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ON

THE DISEASES

OF THE

BLADDER AND PROSTATE GLAND.

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ON

THE DISEASES

OF THE

BLADDER AND PROSTATE GLAND.

BY WILLIAM COULSON,

SURGEON TO ST. MARY'S HOSPITAL, &c.

Fourth Edition, Revised and Enlarged.

LONDON:
JOHN CHURCHILL, PRINCES STREET, SOHO.
MDCCCLII.

LONDON:
G. J. PALMER, SAVOY STREET, STRAND.

15090
7/9/91

TO

JOHN F. SOUTH, ESQ.,

PRESIDENT OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND,

AND SURGEON TO ST. THOMAS'S HOSPITAL,

The following Pages

ARE OFFERED

AS A TRIBUTE OF RESPECT AND ESTEEM,

BY

HIS OBLIGED AND FAITHFUL FRIEND,

THE AUTHOR.

ADVERTISEMENT

TO THE

FOURTH EDITION.

Nearly ten years have elapsed since the publication of the last Edition of this Work. This period has been peculiarly distinguished by the application of chemical knowledge to an elucidation of many of the phenomena occurring in the animal economy, and by the aid which the microscope has afforded in minute anatomy and in the examination of the urinary deposits. Of the discoveries resulting from these sources I have availed myself in the present Edition, and have devoted to their application and illustration such intervals of time as an active professional life would admit.

I trust my Work, imperfect though it be, will be received in the same kindly spirit as the previous Editions; I have endeavoured to convey in it useful lessons to the Student in Surgery, and to offer a faithful guide and help to the Practitioner.

London, February, 1852.

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CHAPTER XXII.

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DISEASES

OF THE

BLADDER AND PROSTATE GLAND.

CHAPTER I.

THE URINE.

Of the excretory organs none are more important than the kidneys; none, having their functions diminished, depraved, or suspended, give rise to more alarming symptoms; none, having their structure disorganized, are attended by greater pain, or have that event followed by greater danger. So important, and indeed essential, are the kidneys to the functions of life, that we find organs either similar or analogous to them in all animals, down to the lowest grade of animated beings. Birds, amphibia, and fishes, have kidneys which are formed of one substance only, resembling the cortical of mammiferæ, without either nipples or calices; and Brugnatelli, Meckel, and Blainville, have discovered an excretion analogous to urine in insects and mollusca.

Even in vegetables there is an analogous function; for the experiments of Schuebler and Zeller have ascertained, that plants which have absorbed different organic and inorganic noxious matters by their roots, get rid of them by their leaves.

It is long since physiologists observed that of the organic elements of the body the kidney throws forth nitrogen, the liver hydrogen, and the lung carbon ; and even the more exact views of recent times have hardly overthrown the distinction. It clearly appears that the use of the kidney and of the lung is to get rid of the chemical products continually produced within the living body by the death and decomposition of the organic parts of which it is composed. It is not necessary that we should strictly bind ourselves to any one of the special theories by which the successive steps of the great process of transformation of tissue is accomplished. It is enough that we are satisfied that the textures of the living body do, without ceasing, undergo chemical decomposition, the place of the decayed particles being as constantly supplied by the assimilation of new alimentary matters received into the stomach, and that the decomposed parts are ejected from the body by the kidney, by the lung, and, in some part at least, by the liver. It is quite certain that the food and the oxygen which the living system is constantly receiving from without are not mere stimulants to action ; but that they actually enter into the chemical composition of the substance of which the body consists, and thus that while the body remains unchanged, the constituents of the egesta must be correspondent to the constituents of the ingesta. This is sufficiently proved when the constituents of the excretions now enumerated and that of the skin are compared, qualitatively and quantitatively, with an average amount of food, drink, and oxygen consumed in a given time by a living body.

Such, then, is the general description of what takes place during the continuance of health. But under the multitude of noxious influences to which the living body is continually exposed, it cannot but happen that derangements should occur, by the loss of healthy action, in the processes described; and hence that the effects of these derangements will become apparent in the character of the egesta, and more particularly in that fluid by which in the healthy state the greatest number of the elements of the body are thrown forth —that is, the secretion of the kidney. Hence arises the importance of becoming acquainted with the range of the constituents of the urine in health as well as with the changes to which, under the vast variety of morbid actions, it must become subject. In diseases of the bladder and prostate gland, the secretion of urine is often so much deranged, as to render a knowledge of the changes which it undergoes, indispensable to the successful management of these affections; and the physician might as well attempt to treat disorders of the organs of circulation and respiration without the stethoscope, as the surgeon those now under consideration, without such knowledge as I have alluded to.

I have, therefore, deemed it necessary to prefix here an account of the alterations to which modern science has shown this fluid liable, and of the practical indications afforded by its various appearances.

In the healthy state of the urine there are four classes of constituents, viz., water, nitrogenized organic matters, non-nitrogenized organic matters, and salts. This composition corresponds with the constitution of the food and of the blood. To the second class belong urea and uric acid ; to the third fatty and colouring matters ; and to the fourth the salts, such as the phosphates of the alkalies and of the earths.

Healthy urine varies in quantity, in colour, and in density. The quantity is about forty ounces in twenty-four hours, being smaller in summer than in winter. The specific gravity is from 1·012 to 1·030, the mean density being 1·022. On standing a slight cloud appears in the urine ; after filtration there is little tendency to putrefaction ; and until putrefaction occurs, it is acid to test-paper. The urine is of a more or less deep citrine colour, and, with the exception of the slight cloud before spoken of, it is transparent ; but when putrefaction commences it becomes turbid. Slight differences in the urine occur in the two sexes, and at different ages. Many common chemical reagents afford copious precipitates with the urine. Lime-water gives a moderate precipitate even after considerable dilution ; solution of acetate of lead or of nitrate of barytes gives a copious precipitate, part of which is re-dissolved by nitric acid ; sulphuric or nitric acid heightens the colour and smell of urine. At specific gravity 1·014, 1000 grains of urine contain about 32 grains of solid matter ; at specific gravity 1·020 the same quantity contains about 46 grains ; at specific gravity 1·025 the same quantity contains about 58 grains ; at specific gravity 1·030 the same quantity contains about 69 grains ; and at specific gravity 1·040 the same quantity contains about 93 grains. But these numbers are not uniformly correct. Indeed other formulæ have been given, all different and all inapplicable. The solid contents of the urine cannot be told from the specific gravity; and the only correct method of estimating them is by actual evaporation and weighing.

Quantity of Urine secreted.—According to Dr. Prout, the average quantity of urine secreted, within twenty-four hours, in this country, varies from 30 to 40 ounces. Dr. Routh makes the average quantity somewhat less, saying that it does not exceed 35 ounces. In France, according to Becquerel, the average quantity is 43 ounces in men and 47 ounces in women. Diuresis is the term employed to signify a simple increase in the secretion of the urine. The term diabetes should not be employed unless when the urine is not only greater in quantity but also saccharine in quality. Diuresis sometimes attends the cold stage of intermittent fevers; in continued fevers of a phlogistic type it forms a favourable crisis, and it sometimes predominates throughout the whole disease in those fevers in which disturbance of the nervous system prevails over that of the vascular system. The like observation may be made of eruptive fevers, such as measles and small-pox; nevertheless, a free discharge of urine not unfrequently ushers in malignant forms of eruptive fevers. In inflammations, the urine seldom increases until the crisis occurs, and then it is not unfrequent, for example, in pleuritis, peripneumonia, hepatitis, and cynanche parotidea. Of chronic diseases diuresis is most remarkable in hysteria, asthma, rheumatism, gout, and spasmodic colic.

Scanty urine attends active inflammation and phlogistic states of the system, as when the inflammatory type marks continued and eruptive fevers. In these diseases scanty urine, after a favourable crisis, threatens a relapse. Scantiness of urine is also among the first symptoms of approaching disease. Of chronic diseases urine is scanty in congestions of the abdominal organs, in colica pictonum, and some other forms of colic, in diseases of the liver, of the heart, &c.

As a general rule, in disease, as well as in health, when the quantity of urine is increased its density diminishes, and *vice versâ.* There are, however, exceptions to this rule; for example, diuresis with increased discharge of urea, which corresponds to the old diabetes insipidus; and diuresis with saccharine urine, or the true diabetes.

Colour of Urine.—In health the colour of the urine varies in different individuals, from pale straw or citrine to orange, approaching red. As a general fact, it is to be remarked that the colour is deeper as the constitution of the individual is more robust, the circulation more active, and the food more of an animal nature.

The urine of persons in health is usually of a pale amber colour, becoming slightly turbid towards the centre, seven or eight hours after having been passed, and shortly depositing a sediment that rises up in the form of a cone from the centre of the fluid. This deposition which, at first, is in small quantity, increases until putrefaction renders the whole of the urine turbid.

It is essential to distinguish whether the colour be owing to the food that may have been taken, or to any medicine that has been administered. Urine, for example, becomes limpid if much drink has been swallowed ; red, if there has been much exercise, or a paroxysm of passion, long-watching, heating diet, much fasting, or the use of water-cresses, beet, sorrel, or madder. It is tinged blackish by chalybeates ; yellow by saffron, turmeric, and rhubarb ; in short, no secretion is more variable in its physical attributes than urine.

The state of the body greatly modifies the quality of the urine. We know, for instance, how limpid, colourless, and watery it becomes after any spasmodic paroxysm, and in the cold stage of agues ; turbid, yellowish, and mucous at the termination of pituitous or catarrhal affections ; golden yellow and turbid in jaundice ; turbid, accompanied with deposition of mucus in catarrhal affections of the bladder.

Pale limpid urine in a state of health is regarded as the consequence of indigestion ; and hence, we find it a very usual symptom of dyspeptic headache ; or it may proceed from constipation* or suppressed perspiration. This limpidness of the urine is a dangerous sign in continued and intermittent fevers, and especially in affections of the brain.† In old people the urine is usually pale, and dull, and cloudy. Colourless limpid urine, which is like spring-water as well as inodorous and insipid, is called nervous urine.

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* Hippocrates notices this fact. In the Eighty-third Aphorism, Section IV., he says, " Abundant urine during the night denotes that the bowels are not sufficiently open."

† This is another remark to be found in Hippocrates (V. Aph. Seventy-two, Sect. IV.), which Celsus (lib. ii. cap. 4) repeats.

The urine is clear, transparent, and insipid in spasmodic affections, in hysteria, hypochondriasis, and epilepsy. It is equally transparent and clear, but usually abundant, in diabetes. The odour of urine is likewise often a valuable indication of the morbid condition and nature both of the particular organs concerned in its secretion and evacuation, and of the general health.

Smell of Urine.—The odour of healthy urine is somewhat aromatic without acidity, ammoniacal smell or fetid taint; and resembles, in a great degree, the odour of the perspiration of a healthy man.

The urine of persons affected with stone in the bladder often acquires a highly offensive odour. The urine of diabetic patients has usually a sweet wheyey smell. Indeed their whole persons exhale a similar odour.

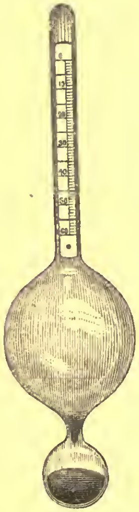
It has been long noticed, that certain substances when eaten or even when respired, impart a peculiar odour to the urine. Hippocrates, for instance, mentions that garlick and other strong smelling substances impart their particular odour to the urine.

Oil of turpentine enters the circulation by respiration, and is conveyed to the kidneys in the same way; the odorous principles of asparagus, cauliflowers, fennel, juniper-berries, valerian, castor, balsam of Peru, copaiba, cubebs, and many other substances likewise pass through the blood into the urine.

In persons of delicate constitution, and those of a weak digestion, we can often recognize by the odour of their urine the nature and character of the food they have eaten. Fourcroy, observes that the urine of hysterical females, and of hypochondriacal men, passed immediately after a meal, has smelled of bread, bouillon, and other articles of food ; circumstances attributable to the odorous molecules which had entered the blood being afterwards excreted by the kidneys.

Modes of estimating the density of Urine.—To estimate exactly the density of the urine is a point of much moment. The most exact method of determining its density is by what is termed the 1000 grain bottle. This bottle contains exactly 1000 grains of distilled water. It is sold by the instrument makers along with a piece of brass which exactly counterpoises it. When it is filled with urine and weighed, the counterpoise being also put into the opposite scale, we obtain at once by its weight in grains, the density of the urine as compared to 1000 the density of water.

The same accuracy may be obtained with any thin phial, though with considerably more trouble. The weight of the phial is first to be determined empty. It is then to be filled with distilled water and weighed in grains. It is then filled with urine and again weighed in grains, the counterpoise weight being put into the opposite scale. The weight of the water is to the weight of the urine which it contains in the ratio of the density of the water to the density of the urine. Then by the rule of three the density of the urine, as compared with 1000, the standard of water, can easily be brought out. As the weight of the water is to that of the urine, so is one or one thousand to the density of the urine. But since the third term is one, the practical rule is merely to divide the weight of the urine contained in the phial by the weight of the water contained in the same, and the product is the density of the urine as compared with that of water when the standard is made 1 or 1000.



An easier mode, however, of estimating the density of urine, though with less accuracy, is by a small hydrometer, termed a urinometer. The urinometer consists of a small globe of glass containing air, beneath which is a much smaller globe filled with a portion of mercury; from the upper part of the larger globe a slender stem arises to which the scale of degrees is attached. When this instrument is put into distilled water, it sinks almost to the top of the stem at which the scale commences, being there marked 1. The scale is divided into 60 degrees, and when the instrument is placed in a fluid of greater density than water, the number of the scale at the surface of the water shows how much the fluid exceeds the density of water beyond 1000 up to 1060. Thus, suppose the water's edge cut the scale at figure 26, then add that number to 1000, and the specific gravity will be 1·026. In order to ascertain the quantity of solid matter in 16 fluid ounces of urine, it is only necessary to refer to the following table constructed by Dr. Henry, which enables us to determine, without the trouble of evaporation, the quantity of extract contained in the pint (16 oz.) of different specific gravities, from 1·020 to 1·050.

Specific gravity at 60° F.	Solid extract in a wine pint in grs.	Solid extract in wine pint in oz.			
		oz.	dr.	scr.	grs.
1·020	382·4	0	6	1	2
1·021	401·6	0	6	2	1
1·022	420·8	0	7	0	0
1·023	440·0	0	7	1	0
1·024	459·2	0	7	1	19
1·025	478·4	0	7	2	18
1·026	497·6	1	0	0	17
1·027	516·8	1	0	1	16
1·028	536·0	1	0	2	16
1.029	555·2	1	1	0	15
1·030	574·4	1	1	1	14
1·031	593·6	1	1	2	13
1·032	612·2	1	2	0	12
1·033	632·0	1	2	1	12
1·034	651·2	1	2	2	11
1·035	670·4	1	3	0	10
1·036	689·6	1	3	1	9
1·037	708·8	1	3	2	8
1·038	728·0	1	4	0	8
1·039	747·2	1	4	1	7
1·040	766·4	1	4	2	6
1·041	785·6	1	5	0	5
1·042	804·8	1	5	1	4
1·043	824·6	1	5	2	3
1·044	843·2	1	6	0	3
1·045	862·4	1	6	1	2
1·046	881·6	1	6	2	1
1·047	900·8	1	7	0	0
1·048	920·0	1	7	1	0
1·049	939·2	1	7	1	19
1·050	958·4	1	7	2	18

Variations of density.—The density of the urine varies in the same person at different times of the day. When, therefore, great accuracy is required, the whole of the urine passed in the twenty-four hours should be collected, and a portion tried by some one of the above methods. If the whole of the urine for one day cannot be obtained, the medium should be taken between that of the morning and the evening. It is common to take the morning urine alone; but it appears that, in disease at least, the morning urine is usually less dense than that of the evening. The morning urine corresponds to what the older authors called the urina sanguinis; the evening urine, to what they termed the urina chyli. The urine passed after much drink was formerly termed the urina potûs, and this has often a very small density. Hence, in those who habitually drink much, the specific gravity of the sum of the quantities passed in a day is below the average. It is plain, then, that to estimate with accuracy the density of the urine, the quantity passed in a day is to be taken into account along with the density of the sum. It appears that the average quantity of urine passed by the inhabitants of France in a day is higher than that passed by the inhabitants of England. And hence it is not surprising that Becquerel should make the mean density of the urine in the two sexes no more than 1·017, while Prout makes it 1·020.

The density of the urine taken together, with the quantity passed in a day, has been used to determine how much solid matter is lost by the body in a given time through the kidneys. The calculation on this plan does not admit of much accuracy, but nevertheless it may be useful. The difficulty of attaining accuracy in this matter arises from the variable quantity of each ingredient present at different times. Dr. Golding Bird, taking for his basis a table drawn up by Professor Christison, says, that when the specific gravity of the urine is expressed by four figures, the two last figures approximately indicate the number of grains of solid matter in every ounce of the urine. This, however, must be taken as merely an approximation.

The chemical constituents of healthy urine.—It appears that the urine contains from three and a half to seven per cent. of solid matter, the rest being water. According to the original analysis by Berzelius, published in 1809, the proportion of solid constituents in a thousand parts of urine amounts to sixty-seven parts, or to nearly seven per cent. The urea amounts to about three per cent.; the uric acid to one-tenth per cent., the free lactic acid, lactate of ammonia, alcoholic and watery extract, to one and seven-tenths per cent., the mucus to three hundredth parts per cent., the alkaline sulphates to seven-tenths per cent., the phosphate of soda to nearly three-tenths per cent., the biphosphate of ammonia to a tenth and a half per cent., the chloride of sodium to upwards of four-tenths per cent., the chloride of ammonium to one-tenth and a half per cent., the phosphate of lime and magnesia to one-hundreth per cent., the silicic acid to three one-thousandth parts per cent. We here cite in the first place the tabular analysis by Berzelius referred to, and give in contrast some more recent analyses.

Water	933·00
Solid residue	67 00
Urea	30·10
Uric acid	1·00

Free lactic acid, lactate of ammonia, alcohol, and water-extract	17·14	
Mucus . . .	0·32	
Sulphate of potash . .	3·71	Fixed salts 15·29
Sulphate of soda . .	3·16	
Phosphate of soda . .	2·94	
Biphosphate of ammonia .	1·65	
Chloride of sodium . .	4·45	
Chloride of ammonium .	1·50	
Phosphate of lime and magnesia	1·00	
Silicic acid . . .	0·03	

Simon made two analyses of the urine of a healthy man, aged 33 years, of a decidedly sanguineous temperament, whose digestion and nutrition were not very good. One hundred parts contained:—

Specific gravity .	1011		1012	
Water . . .	963·20		956·00	
Solid residue .	36·90		44·00	
Urea . .	12·46		14·578	
Uric acid .	0·52		0·710	
Alcohol-extract, with free lactic acid	5·10	Extractive matter and ammonia salts. = 10·14	4·800	=12·94 and amm. salts.
Spirit extract .	2·60		5·590	
Water-extract and vesical mucus	1·00		2·550	
Lactate of ammonia	1·03			
Chloride of ammonium . .	0·41			
Chloride of sodium	5·20	11·19	7 280	13·77
Sulphate of potash	3·00		3·508	
Phosphate of soda	2·41		2·330	
Phosphate of lime and magnesia .	0·58		0·654	
Silicic acid .	a trace.		a trace.	

C. G. Lehmann has likewise made some very minute analyses of the healthy urine of a young well-fed man. These analyses approximate closely in their results to those of Berzelius. They were made with the collected urine of the past twenty-four hours. The concentration of the fluid may be explained by the circumstance of the young man by whom the urine was passed, taking only a very little drink, as is the usual habit with a sanguineo-bilious temperament.

	1.		2.		3.	
Water	937·682		934·002		932·019	
Solid residue	62.318		65·998		67·981	
Urea	31·450		32·914		32·909	
Uric acid	1·021		1·073		1·098	
Lactic acid	1·496		1·551		1·513	
Water-extract	0·621		1.591		0·632	
Spirit and alcohol extract	10·059		9·871		10·872	
Lactates	1·897		1·066		1·732	
Chloride of sodium and ammonium	3·646	15·857	3·602	15·744	3·712	16.130
Alkaline sulphates	7·314		7·289		7·321	
Phosphate of soda	3·765		3·666		3·989	
Phosphates of lime and magnesia	1·132		1·187		1·108	
Mucus	0·112		0·101		0·110	

The following table gives the mean result of six analyses of the morning urine of a healthy man, instituted by Simon.

Specific gravity	1022·5
Water	961·00
Solid constituents	39·00
Urea	16·60
Uric acid	·61
Fixed salts	9·27
Organic matter and loss	12·07

The apparent discrepancies in the composition of healthy urine, as shown in the analyses that have been quoted, depend for the most part on the fluctuating amount of water. If we calculate the proximate constituents of the urine in relation to an equal amount of solid residue, we shall find these differences exhibited in a much less striking manner, although to a certain degree they still exist.

One hundred parts of the solid residue of the urine contain :—

Urea	33·80	33·10
Uric acid	1·40	1·60
Extractive matter, ammonia, salts, and chloride of sodium	42·60	46·00
Alkaline sulphates	8·14	8·80
Alkaline phosphates	6·50	5·70
Phosphates of lime and magnesia	1·59	1·50

Water forms the basis of blood and urine, as well as of all animal fluids ; nevertheless, in the blood, it appears probable that water exists in two distinct conditions : first, as an integrant constituent of the corpuscular portion ; and, secondly, as diffused generally throughout the mass. It is from the latter source that the urine is taken. There is sometimes an increase of the watery portion, whilst the other principles remain the same, or become diminished. In this state of the urine, the urea and the salts bear to each other nearly their ordinary proportion, but are considerably deficient in their absolute quantity. This condition of the urine may be observed in most persons under particular circumstances, especially in the aged ; where it is only occasional, much importance is not to be attached to it.

But where this state is constant it becomes an important indication, showing great weakness and debility of constitution, and is not unfrequently the precursor of serious local and constitutional mischief. Sometimes the increased flow of urine, as Dr. Prout observes, involves an increased proportion of the natural ingredients, as of urea; or of unnatural ingredients, as of albumen or sugar. On the other hand, the proportion of water is not unfrequently diminished below the natural standard, as in various forms of urinary suppression; and sometimes when the cause of this suppression is mechanical, the urine is simply diminished in quantity, while its composition remains the same: at other times, the suppression is connected with deranged action of the kidneys, and while the proportion of water is diminished, the other ingredients are relatively much increased, as in various forms of gravel and calculus.

Urea.—The chief constituent of the urine is urea. It is an organic constituent, though it differs from other organic constituents in general by being crystallizable. It is long since the first germ of the discovery of urea appeared in chemistry; for, under the name of extracts of urine, an impure urea was early distinguished from the saline ingredients. In the last century Rouelle made a great advance in this subject. He describes, besides the saline matter of the urine, two substances, one soapy, the other extractive; the first soluble in alcohol, the second insoluble in that menstruum. The soapy substance he describes as of a brown colour and fetid odour, an unctuous consistence, crystallizable like a saline body, not easily susceptible of exsiccation, attracting humidity from the air, and giving by analysis more than half its weight of volatile alkali, a little oil, and sal ammoniac. This description plainly is a near approach to the characters of urea. His observations were for a long time neglected. At last Cruikshank, when he assisted Rollo in his examination of diabetic urine, made a new step in the discovery of urea.

He showed that a peculiar crystallizable substance exists in the urine which is precipitated from it by nitric acid. His experiments were published in 1797, and three years after Fourcroy and Vauquelin published an elaborate memoir on the urine, in which urea is particularly described. In this paper Fourcroy says, that he and Vauquelin had discovered all that Cruikshank had made known, previously to his publication.

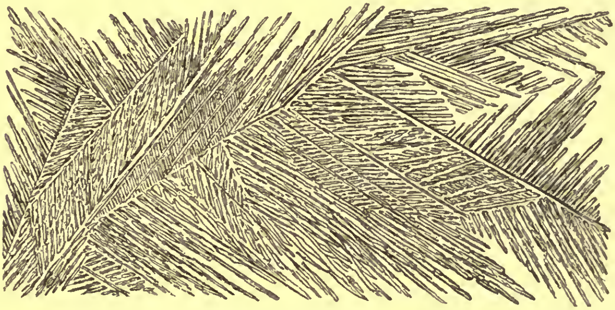
But Berzelius remarks that Fourcroy was hardly the person to suppress, for so long a period, a discovery of this importance. Fourcroy and Vauquelin named the new substance uree or urea : they obtained it by evaporating the urine to the consistence of a thick syrup and extracting the urea from this mass by means of alcohol. It is to be remarked, that before Cruikshank or the French chemists had published this discovery, Scheele had discovered the existence of uric acid in healthy urine.

For a number of years no purer form of urea was known to chemists than that which can be obtained by the process of Vauquelin and Fourcroy. At last Berzelius devised a new process, and about the same time Prout also published another. The process of Berzelius essentially consists in extracting first an impure urea from urine evaporated as far as possible to dryness by means of anhydrous alcohol. The impure urea so obtained is freed from colour by animal charcoal, and being then dissolved in a small quantity of distilled water, oxalic acid is added to it. An oxalate of urea is formed which is finally decomposed by carbonate of lime, the oxalate of lime formed being separated by filtration.

One of the best methods now proposed for procuring urea consists in evaporating fresh urine to the consistence of a syrup with a gentle heat and mixing it, while still warm, with its own volume of colourless nitric acid of specific gravity 1·420. The whole now forms a thick crystalline mass. By the action of the nitric acid on the warm solution, heat is developed and effervescence ensues. This is chiefly owing to the destruction of the colouring matter, and if any considerable heat is applied, the urea not only is not decomposed, but forms, from the first, nearly white crystals of nitrate of urea. When cold is employed, according to the method formerly recommended, the crystals are very brown, and are purified with difficulty. It is advisable to separate from the inspissated urine, by crystallization, as much as possible of the chlorides which it contains, before adding the nitric acid. (*Cap and Henry ; also " Turner's Chemistry," by Liebig and Gregory*, p. 726.)

The chemical constitution of urea is represented by $C_2 N_2 H_4 O_2 = 60$. Urea is a cyanate of ammonia, and it may be prepared artificially—for example, by Liebig's process. Ferrocyanide of potassium and peroxide of manganese are mixed in powder and calcined. The mass when cold is powdered and subjected to the action of cold water, which dissolves cyanate of potash. Sulphate of ammonia is now added ; the sulphate of potassa formed is separated, and the cyanate of ammonia is evaporated to dryness, and in this process it passes into urea. The dry mass is digested in alcohol, which dissolves only the urea, and yields it from the first chemically pure.

Urea crystallizes in colourless, transparent, four-sided, somewhat flattened prisms of the specific gravity 1·350.



CRYSTALS OF UREA.

It is soluble in its own weight of cold water, and in every proportion of hot water; in 4·5 parts of cold, and in 2 parts of boiling alcohol. The aqueous solution has a cooling bitter taste like nitre. When pure it is perfectly permanent in the air, is not deliquescent, fuses at 250° into a colourless liquid, is decomposed by a higher temperature into ammonia, cyanate of ammonia, and dry solid cyanuric acid. Alkalies do not cause the separation of ammonia in the cold. Urea is an organic base, and unites with several acids without decomposition to form crystallizable saline compounds. The chief of its known salts are the nitrate and the oxalate.

About 240 grains, or half an ounce of urea, are daily separated by the kidneys from the blood. This quantity represents five-sixths of the nitrogen taken in with the food. Urea cannot be detected in healthy blood, but after the extirpation of the kidneys in animals and in Bright's disease, also in cholera, it has been distinctly shown to be present in this fluid. It appears also to have been discovered in the secretion of the skin, in evacuations of the bowels produced by powerful medicines, and it is even said to have been detected in the humours of the eye. In animals, however, after extirpation of the kidneys, it appears that the elements of urea pass from the bowels in the form of carbonate of ammonia.

According to Prout, urea is derived in the living system from the metamorphosis of the gelatinous tissues, while uric acid is derived from that of the albuminous tissues.

Liebig, on the other hand, maintains that uric acid is the immediate product of the decomposition of all nitrogenized tissues, and that, by the action of oxygen and water, it is converted into urea, which is thus, according to him, a secondary product of animal decomposition.

Abnormal states of Urea.—Several names have been applied to signify abnormal states of urea in the urine, such as anazoturia, azoturia, and anuria. The first, viz., anazoturia, includes many cases of diabetes insipidus. *Anazoturia* signifies a discharge of urine which is characterized by a deficiency of urea. Many cases of diabetes reported as cured plainly belong to this head. It is marked by a great abundance of urine which is limpid and straw-coloured, or wholly free from colour, has a slight faint odour, and either a weak reaction with litmus paper or is altogether neutral. Such urine rarely precipitates within twenty-four hours; but cannot be kept without undergoing change, usually becoming faintly ammoniacal. It forms a fine creamy pellicle containing minute pearly white crystals of ammoniaco-magnesian phosphate. This state of disease occurs most commonly among indifferently fed children; there is usually great emaciation, protuberant belly, voracious appetite, and great thirst; the specific gravity of the urine but little exceeds that of distilled water: caustic potash precipitates a few flocculi consisting of urate of ammonia; by analysis a very small quantity of urea can be detected in this urine.

Among other symptoms of this affection are gnawing sensations at the pit of the stomach, a white furred tongue, constipation and parched skin, and depression of spirits. The prognosis is rather unfavourable.

Azoturia signifies a discharge of urine characterized by a superabundance of urea. This affection is another of the morbid states which have been described under the name of diabetes insipidus. The quantity of urine secreted is often unusually large,—the fluid is transparent, and most commonly light-coloured, though in some instances it is so dark as to have been likened in colour to porter; it exhales a faint urinous odour, and has an acid reaction with litmus paper ; the specific gravity is commonly high, varying at different times of the day between 1·018 and 1·035.

When the density of this urine is at the highest, it affords crystals of nitrate of urea on the addition of nitric acid after a few hours rest, and without being previously concentrated,—and even when the specific gravity is somewhat less, crystals of nitrate of urea are obtained on the addition of nitric acid with a less previous concentration than is usually required.

The symptoms attendant on this kind of constitutional disturbance are commonly loss of strength, feelings of languor, a greater or less degree of emaciation, some thirst, frequently a sense of sinking, and an uneasy gnawing pain at the pit of the stomach. The patients affected with this malady often show a peculiar anxiety of expression and cast of countenance, which, according to Dr. Willis, (*Urinary Diseases and their Treatment*, p. 20,) is common to most of the diseases characterized by a too copious secretion of urine variously altered in its qualities.

It was once supposed that urea is altogether absent in the urine of the true diabetes. This has been found to be an error. It is now many years since this mistake was suspected ; Dr. Henry was among the first to discover that urea uniformly existed in a certain proportion in diabetic urine ; then Mr. Kane taught that it is present in as large a proportion as in health ; and finally Mr. Macgregor showed that, under certain circumstances, diabetic urine contains a larger proportion of urea than healthy urine. According to the last named author, a patient labouring under diabetes mellitus, who had undergone no treatment, passed 1,013 grains of urea daily, while the estimated quantity of that passed by a person in health was no more than 428 grains ; again, a second patient was found to be passing 945 grains, and a third 810 grains of urea every day. He adds that a patient fed on beef and water exclusively for three successive days passed by the urine 43 grains of urea for every 1,000 grains of urine ; while the same quantity of healthy urine rarely contains so much as 30 grains. The increased specific gravity of diabetic urine is not, however, in general, due either to an excess of urea, of uric acid, of the urates, or even of the saline ingredients, but almost exclusively to the large proportion of sugar which is present.

There is one morbid state of the urine, however, in which the increase of its specific gravity is plainly dependent on an excess of urea, viz., in what is termed the oxalic diathesis. When oxalate of lime is present in the urine, the density is generally above the healthy standard, and this increase of density appears to be owing to an excess of urea. Thus in the morbid condition of the system depending on the presence of oxalate of lime, the urine, though it agrees with diabetes in showing a higher density, has no other analogy with it ; deposits of uric acid and urates of ammonia being also frequent in this state.

The form of disease, termed azoturia by Dr. Willis, is common in children, and not unfrequent in persons who live freely. It especially attacks persons of spare habit and nervous temperament. There is the same hollow-eyed anxiety of expression before spoken of, thirst, and emaciation; but the debility is not so marked as in the former affection. There is, however, the same sense of sinking and uneasy gnawing pain at the pit of the stomach. It has been observed to attend on peritonitis and certain continued fevers of bad type. The prognosis is not, however, so unfavourable as in the former affection.

While treating of urea it is proper to mention its absence in the secretion of urine. This is the disease which Dr. Willis terms *anuria,* and it corresponds to what has been so long known as the ischuria renalis. It is well known that when this morbid condition continues complete for a few days, death occurs by what has been termed apoplexia venenata. Professor Christison of Edinburgh first pointed out the suppression of the excretion of urea as a probable cause of unlooked-for fatal results in acute diseases in general. Professor Henderson of the same university afterwards drew attention to cases of epidemic continued fever in which the defective excretion of urea appeared to give rise to fatal affections of the brain, affirming that in such cases urea might be detected in the blood, and even in the serum collected from the ventricles of the brain. The same morbid state of the urine is often observed in inflammations, in the anasarca which follows scarlatina, and after severe surgical operations. Sometimes this affection seems to be idiopathic, and has been described in children under the title of urodialysis neonatorum. Infants so affected void the urine in very small quantites, of high colour, giving a deep reddish-yellow stain to the linen; it causes great pain in its passage, scalding the surface over which it runs, and excites inflammation in the mucous lining of the bladder and urethra, as is indicated by the quantity of mucus which the urine contains. There is much febrile excitement, the skin is hot and dry, the bowels obstinately constipated, the fæces appear as rounded masses like marbles; the digestion is plainly impaired, the breath smells strongly of vinegar, and, as is often the case in urinary affections, the skin is generally irritable and the seat of various kinds of eruptions.

There is also an analogous disease in the decline of life termed the urodialysis senum, and described by Schönlein. This disease usually sets in with constipation of the bowels, the skin is rough and dry; the tongue is covered with a white fur, red at the margins; the digestive powers are weakened; the appetite fails or is irregular; there are acid eructations and much thirst. The skin, as in the infantile disease, is apt to be covered with eruptions.

Before leaving the subject of urea I must not omit to mention the experiments performed by Dr. Lehmann of Leipzig. This eminent physician compared the proportion of urea excreted while he lived on a strictly animal diet with that given forth when his food was wholly vegetable, and also when it was a mixed diet, and when the diet was quite free from nitrogen, as consisting of starch, gum, oil, sugar, &c. When his diet was wholly animal, the amount of urea obtained in twenty-four hours was 819·2 grains; when his diet was wholly vegetable in the same period there were obtained 346·5 grains; when his diet was mixed the quantity obtained was 500·5 grains, and when his diet was free from non-nitrogenized substances the quantity was no more than 237·1 grains. Lecann has also made some important observations on the variations in the secretion of urea according to the age of the person. He found the average quantity of urea secreted by adult men in twenty-four hours to be 431·9 grains, while 13·09 grains of uric acid were thrown off in the same time,—the quantity of urea in adult women to be 284·2 grains, the uric acid in the same period being 10·01 grains,—the quantity of urea in very old men (84 to 86 years old) 124·8 grains, while the uric acid in the same period was 6·77; the quantity of urea in children under 8 years 138·2 grains, the uric acid in the same time being 3·98 grains.

Uric Acid.—Uric acid is another most important constituent of the urine. It was discovered in the last century by Scheele, a Swedish chemist, who found this substance to form a principal part of some urinary calculi submitted by him to analysis; and hence he was led to search for the same substance in the urine of healthy persons. He called it lithic acid, for which name Fourcroy afterwards substituted that of uric acid. It exists in the urine of men and carnivorous animals, but not in that of the herbivorous mammalia. It is, however, found very commonly in other classes of animals, even in those of the lower tribes. Chemists are accustomed to describe it as being found in the mineral kingdom, but this statement is to be understood with an important qualification, since what they refer to is the well-known guano, manifestly the excrement of birds in past ages. Uric acid is deposited from human urine while it cools, and generally in combination with ammonia or with soda as a yellow or brownish powder. The stone-like concretions in the joints of persons labouring under gout contain uric acid in combination with soda or ammonia. It is the basis of the majority of stones found in the bladder. The semi-fluid urine of serpents and birds is principally composed of urate of ammonia. Uric acid crystallizes in flat scales of a brilliant white colour and silky lustre ; it is tasteless and inodorous, heavier than water ; almost insoluble in cold water, and slightly soluble in boiling water ; the solution reddens feebly the vegetable colours. It is dissolved by concentrated sulphuric acid ; and from the solution it is precipitated by water ; it is somewhat more soluble in strong hydrochloric acid than in pure water. Uric acid, when exposed to destructive distillation, affords the same products as are obtained by the decomposition of urea, viz, urea, cyanuric acid, and cyamelide (the insoluble cyanuric acid), also hydrocyanic acid, a little carbonate of ammonia, and, as a residue, a brown carbonaceous substance which is rich in nitrogen. It dissolves in dilute nitric acid with the evolution of equal volumes of pure carbonic acid and nitrogen; the solution contains alloxan, ammonia, and some other compounds ; and this solution, if evaporated and treated with ammonia in excess, acquires a purple red colour, a test by which uric acid may be recognised. Uric acid is insoluble in ether and alcohol. With sulphuric acid it forms a crystalline compound. Its chemical composition is thus represented, $C_{10} N_4 H_4 O_6$.

The average amount of uric acid excreted in twenty-four hours in adults is 8.1 grains, combined, according to some, with soda, according to others, with ammonia.

Since at least 10,000 parts of water at 60° are required to dissolve one part of uric acid, and there must be one part of this substance in 2,500 parts of urine, it is plain that it cannot exist free in the urinary secretion. The compound which uric acid forms with ammonia requires 480 parts of water for its solution. Hence, were it combined with ammonia in the urine, it would remain dissolved at ordinary temperatures, but according to Dr. Bence Jones, uric acid, in the state in which it exists in the urine, requires for its solution 2,789 parts of urine, and he has also pointed out that the presence of a moderate quantity of saline matter increases its solubility. According to Dr. Golding Bird, the 8.1 grains of uric acid uniformly secreted in twenty-four hours require but 0.82 grains of ammonia for saturation, and the 8.92 grains of urate of ammonia thus formed would be held in solution by less than half a pint of water, or about a fourth of the quantity separated by the blood from the kidneys. When healthy urine is slowly evaporated in an air-pump vacuum, it soon becomes turbid from the formation of clouds of urate of ammonia,* which ultimately subside in very minute spherical masses on the sides of the vessel. The same thing occurs when urine of a rather high specific gravity is exposed to cold. These facts have been regarded as conclusive in favour of Dr. Prout's opinion, that the chief part of the uric acid in the urine exists combined with ammonia.

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* Lehmann, however, asserts, in his last edition, that the amorphous lithates do not contain ammonia, but that which is termed urate of ammonia is, in fact, urate of soda.

Acidity of Urine.—Litmus paper is the best immediate test for detecting acidity in urine. When the urine is acid, the blue colour of the paper is changed to a red. Turmeric paper, or reddened litmus paper, is the best test for ascertaining whether urine be alkaline or not. Alkaline urine turns the yellow colour of the turmeric paper brown, and changes the colour of the red litmus paper to a blue : this latter is a much more delicate test than the former. After the discovery of uric acid, the acid reaction of healthy urine to test-paper was naturally ascribed to the presence of that acid. Berzelius first threw doubts on this opinion, affirming that the acidity of the urine is due to the presence of lactic acid ; but of this hereafter. Prout, on the contrary, ascribed the acidity of the urine to the presence of urate of ammonia, and various other opinions have since been published on this point, among which the chief is that the acidity of the urine is due to the presence of free phosphoric acid or to uric acid dissolved by the presence of a phosphate.

Dr. Bence Jones has made some important observations on the variation in the acidity of the urine under different circumstances. From his experiments it appears that immediately before a meal urine exhibits the greatest degree of acidity, and that it is marked by a lower degree of acidity when it is passed two, three, or more hours after food. He found that the decrease of acidity was greatest three hours after breakfast, and that five or six hours after dinner it reached its lowest point. The acidity of the urine then increased until immediately before food, when it again reached its highest limits. When food was not taken the urine did not decrease in acidity, but continued nearly in the same state for twelve hours, and if food was then taken the acidity fell.

When the diet was confined to animal food the decrease of acidity after food was more striking and more durable than when a mixed diet was used. The increase, however, of the acidity before food was hardly so great in this case as when a mixed food was employed; if vegetable food alone was taken the acidity did not sink so much as when animal food was used, that is, though the urine after food became neutral, it failed to become highly alkaline; the increase in the acid quality of the urine was greater before vegetable food than it was when animal food was taken.

According to the experiments of the same author the use of dilute sulphuric acid at the same time hardly altered these results. For example, nine drachms of dilute sulphuric acid in three days slightly diminished the decrease in the acidity of the urine after food; but the acidity before food was very slightly, if at all, increased thereby. The average quantity of carbonate of soda required to neutralize the whole of the urine made in twenty-four hours, when no sulphuric acid had been taken, was 15·39 grains; the average quantity required when sulphuric acid had been taken was 20·38 grains: there was little difference in the quantity of urine made.

He found that tartaric acid in large doses produced a marked effect on the acid character of the urine. He observed that liquor potassæ in large doses had a great effect in diminishing the acidity of the urine, though it by no means rendered the urine constantly and permanently alkaline, its effect passing away rapidly. An ounce of strong liquor potassæ taken in three days did not counteract or conceal the influence of digestion on the reaction of the urine. He found that tartrate of potash quickly produced a very decided effect on the acidity of the urine; 120 grains of pure dry tartrate of potash dissolved in four ounces of distilled water made the urine alkaline in 35 minutes; in two hours the alkescence had disappeared, but after the next meal the effect of the tartrate of potash was again apparent. Ten drachms of tartrate of potash in three days produced but little, if any, effect on the acidity of the urine, after it had been omitted for twenty-four hours.

Thus it appears from these experiments that the acidity of the urine is always changing, and that these changes depend on the state of the stomach at the time. If there be much acid in the stomach, the acidity of the urine increases, and it commonly reaches its highest limit before food is again taken. Animal food causes a greater variation than vegetable food, and when no food is taken the variation is very slight.

Dr. Bence Jones does not attempt to solve the question what is the cause of the acid character of the urine. He thinks it most probable that it is dependent on the presence of acid phosphate of soda. He thinks it likely that there is generally no free acid in the urine, and that the reaction is due to the presence of an acid salt; though he admits that the quantity of phosphate of soda is sometimes so extremely small as to be incapable of producing the acidity present even under such circumstances.

Dr. Bence Jones infers that the urate of ammonia cannot be the cause of the acid character of the urine, because when the urine is nearly alkaline there is not unfrequently a great abundance of that salt. He states also that the quantity of urate of ammonia varies remarkably; that it is but little affected by different kinds of food, nevertheless a few hours after any kind of food the quantity is increased, and long after all food the acidity of the urine is excessively increased.

Dr. Golding Bird, in his excellent treatise on Urinary Deposits, gives the following as a probable explanation of the mode in which uric acid exists in healthy urine. "Uric acid at the moment of separation from the blood comes in contact with the double phosphate of soda and ammonia derived from the food, forms urate of ammonia, evolving phosphoric acid, which thus produces the natural acid reaction of the urine. If the whole bulk of the urine be to the urate of ammonia formed, not less than about 2,701, the secretion will at the ordinary temperature of the air remain clear, but if the bulk of the fluid be less, an amorphous deposit of the urate will occur; on the other hand, if an excess of uric acid be separated by the kidneys, it will act on the phosphate of soda of the double salt, and hence on cooling the urine will deposit a crystalline sediment of uric acid sand, very probably mixed with amorphous urate of ammonia, the latter usually forming a layer above the crystals, which always sink to the bottom of the vessel."

Before leaving this account of uric acid in the healthy state of the body, it must be mentioned that Dr. Garrod has shown by an ingenious set of experiments that traces of uric acid may be detected in the blood. Professor Scherer has further discovered uric acid in considerable proportion in the spleen, and it appears with hypoxanthine to be an important immediate result of the destructive metamorphosis of this singular organ.

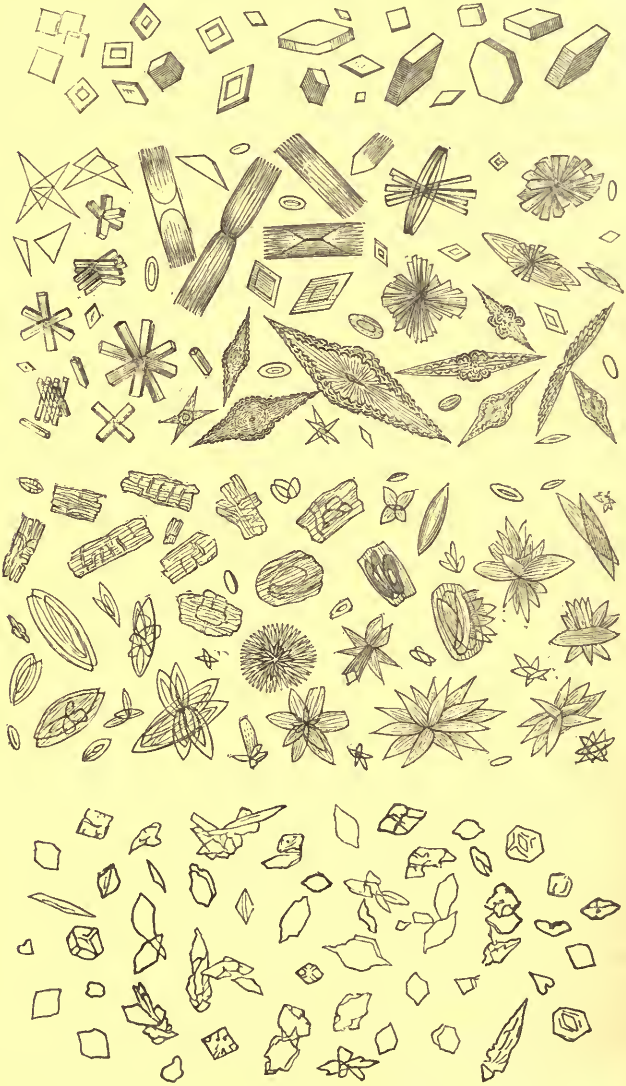
The deposits from the urine, termed uric acid deposits, consist either of uric acid, or of uric acid with urates. When uric acid exists in such a deposit uncombined with a base, it is invariably in a crystalline form, that is, it does not occur in the state of an impalpable amorphous powder. These crystals of uncombined uric acid are seldom free from colour, being most commonly of a yellow or amber tint. They present, however, every shade of colour, from the palest fawn to the deepest amber or orange red, and hence the term yellow or red sand commonly applied to them. As a general rule the higher the colour of the urine the darker are the sediments.

Deposits of uncombined uric acid, when heated in the urine, do not dissolve, but the crystals become opaque. Heated with liquor potassæ, the uric acid deposit dissolves, the urate of potass produced being highly soluble. Nitric acid quickly dissolves the deposit, and by careful evaporation, a beautiful pink-coloured substance is obtained, which on being held over the vapour of ammonia becomes of a rich purple. This coloured substance is the murexide of Liebig, the purpurate of ammonia of Prout. Subjected to heat in a platinum spoon, the uric acid deposits readily burn, giving off an odour of bitter almonds, the residue being usually a small quantity of a white ash, in which there is phosphate of soda or phosphate of lime, or both.

When there is an excess of uric acid in urine, crystals commonly fall when it cools; at other times many hours elapse before a deposit takes place, even when there is comparatively a larger proportion present, and this is frequently observed in gouty persons. At other times the acid is not deposited at all; but forms a crystalline pellicle on the surface affording prismatic colours when placed in a bright light. The urine which deposits uric acid is usually of a deeper amber tint than natural, and is sometimes of a reddish-brown colour. From very high-coloured urine, however, uric acid is seldom deposited until after the addition of a stronger acid; the whole of the uric acid present in the urine is never spontaneously deposited until after the commencement of decomposition, and therefore urine filtered from a sediment of this kind, on the addition of a drop of nitric acid, usually affords a copious deposition of crystals of uric acid in a few hours.

The urine which deposits uric acid invariably reddens litmus paper, and often contains so much urea as to afford crystals slowly without evaporation when mixed with nitric acid. The specific gravity of such urine is commonly above 1·020; the urine, however, of infants at the breast, of its ordinary pale colour, often deposits uric acid. In this case the deposit is a yellow crystalline sand and the supernatant fluid is frequently of small specific gravity, often 1·006, pale as water, and nearly destitute of urea. The probable explanation of this circumstance is the small proportion of alkaline phosphates present, which it has been supposed are solvents of uric acid.

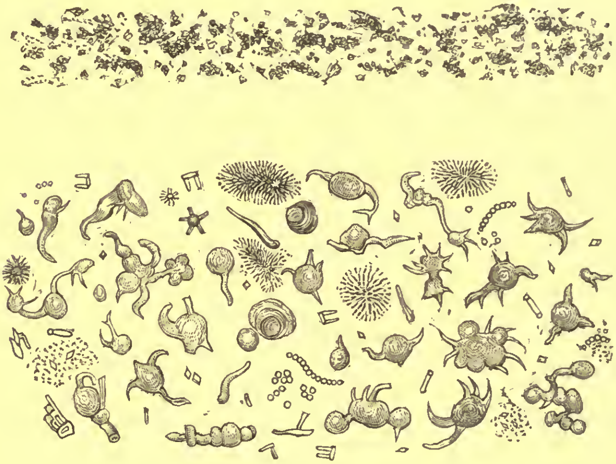
The crystalline forms of uric acid present remarkable varieties. The simple primary form is that of the rhomboid or square, and this undergoes very numerous modifications, as shewn in the following drawings.



URIC ACID CRYSTALS.

Several modifications of urine are found to deposit urate of ammonia; first, a pale urine, of low specific gravity, becoming opaque on cooling from the deposition of nearly white urate of ammonia, which does not fall but forms rope-like masses in the fluid, apt to be mistaken for muco-purulent matter. From this matter, however, it is distinguished easily by its disappearance on the application of heat. Second, urine of a pale amber colour, and of moderate density, from which falls, on cooling, a plentiful fawn-coloured substance not unlike bath brick grated into the urine; this disappears readily on the application of heat. This deposit is of frequent occurrence, being dependent on slight obstruction of the cutaneous perspiration. Third, under febrile excitement the urine becomes concentrated, increases in density, and throws down on cooling a reddish-brown sediment; this is the well-known lateritious or brick-dust sediment. It is to be remarked that a drop of nitric acid renders the urine in this case turbid, not, as has been erroneously supposed, from the coagulation of albumen, but from the precipitation of uric acid in minute microscopic crystals. Fourth, in certain cases of internal disturbance, as in affections of the portal circulation, connected with diseases of the liver or spleen, and sometimes when suppuration is going on internally, the urine exhibits a deep purple or copper colour, often verging on crimson. These deep tints, according to Dr. Golding Bird, depend on the presence of an excess of purpurine. When in such urine a deposit of urate of ammonia occurs, it combines with the pink pigment so as to form a kind of lake, often so abundant as not to disappear entirely by heat until the urine is diluted with water. From these deposits the colouring matter is easily separated by alcohol.

The common form of urate of ammonia is that of exceedingly minute globules, cohering in irregular masses, but it is occasionally found in the shape of larger globules, with one or more caudate processes as seen in the following drawing.

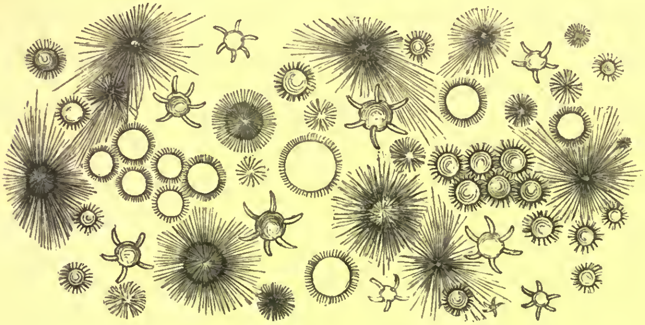


MICROSCOPIC APPEARANCES OF URATE OF AMMONIA.

According to Dr. Bence Jones the proportion of urate of ammonia present in the urine is not indicated with certainty by the amount of the deposit, for if the urine is less acid than usual, it will hold dissolved much more of this salt than when of average acidity, and again that very acid urine may afford a deposit of urate of ammonia when but a moderate proportion of that salt is present.

Of the other salts which uric acid forms, the urate of soda is the most remarkable; it constitutes the tophi or concretions of the joints in gout; it is found, however, also in urine, as in persons suffering under fever, who have been treated with carbonate of soda.

Under the microscope it presents the appearance of crystalline needles, radiating on all sides from a central mass. Sometimes the central mass is very small, or even absent, and the stellate form is produced by the acicular crystals crossing each other.



MICROSCOPIC APPEARANCES OF URATE OF SODA.

It appears that there are two great sources of uric acid, viz,, the disintegration of tissues and nitrogenized food. In all diseases attended with great emaciation an increased quantity of uric acid appears in the urine, if the kidneys remain fit to perform their functions; in acute inflammatory diseases, in acute inflammations supervening upon chronic maladies, in rheumatism, in organic, and even in functional affections of organs materially influencing the circulation, as the heart, liver, and perhaps the spleen, deposits of uric acid, whether free or combined, are commonly present in the urine. In gout and rheumatism there is a striking tendency to the formation of an excess of uric acid both in its pure state and combined. In gouty affections urate of soda appears to be generated in so large a quantity that the fluid part of the blood is no longer sufficient for its solution, and hence part of it is deposited in the joints and sheaths of the tendons producing painful swellings.

In the blood of gouty patients Dr. Garrod has succeeded in discovering urate of soda by the following process : the serum is evaporated to dryness over a water bath, and the dry mass reduced to powder ; this is digested with water at 100° for an hour ; the solution is now evaporated to a small bulk, and a little strong acetic acid added, when acetate of soda will be formed, and, after a few hours, crystals of uric acid will be deposited.

In chronic diseases of excessive debility, particularly where an anæmic or chlorotic state exists, a deficiency of uric acid occurs, and deposits never take place in the urine unless after great evaporation.

When the functions of the skin are impaired, an excess of nitrogen is retained in the blood, and afterwards separated by the kidneys in the form of urate of ammonia.

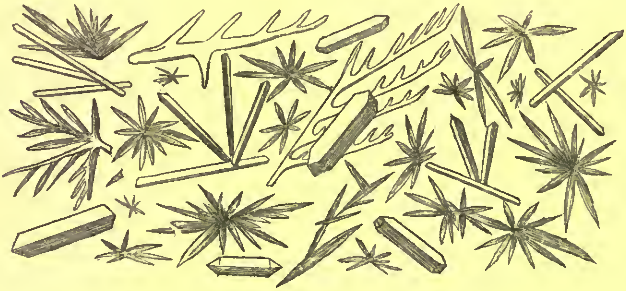
An excess of uric acid may exist in the urine without forming a deposit, and the presence of a deposit does not necessarily imply the existence of an unusual proportion ; if, however, a deposit of the urate of ammonia occur when the bulk of the urine in four-and-twenty hours is not below the average, it is pretty certain that an excess of uric acid exists. But if the bulk of the urine be much less than natural, the deposit may occur merely because there is not enough of water to hold the uric acid in solution.

The most serious effect of the formation of uric acid in excess within the system is the production of urinary calculi ; this acid forms a large proportion of the whole number of urinary calculi, and even when these are chiefly composed of other constituents, the nuclei on which they are deposited are for the most part composed of uric acid. Urate of ammonia, owing to its solubility, hardly forms, except in children, entire calculi ; but combined with other ingredients it often enters into their composition.

Among the curative means, when an excess of uric acid is remarked in the urine, those which promote the functions of the skin hold a chief place. The improvement of the functions of digestion ranks next to these. A due amount of muscular exertion and free exposure to fresh air are of essential consequence. Among special remedies, preparations of iron and colchicum deserve particular attention ; to these are to be added various remedies which seem to act as solvents of uric acid, such as the alkalies and their carbonates, biborate and phosphate of soda, benzoic and cinnamic acids.

Lactic acid.—It was before remarked that Berzelius ascribed the acidity of the urine to the presence of lactic acid. Much doubt still exists as to whether this acid and its salts be or be not ordinary constituents of the urine. Simon regards lactic acid as uniformly existing in the urine, and like Berzelius enumerates lactate of ammonia as one of the ingredients of the urine. Lehmann, Marchand, and Becquerel, agree with Berzelius and Simon in retaining this acid and its salts as a part of the chemical constitution of the urine. Heintz also appears to have shown that though lactic acid is not the cause of the acidity of the urine it is nevertheless present among its constituents.

Hippuric Acid.—At an early period in the chemical history of the urine, several acids were announced as existing in it, besides the uric. Prout and Thenard believed that acetic acid is present in healthy urine; this, however, was disproved. At a still earlier period it was announced that benzoic acid exists in the urine of children, and of herbivorous animals. Rouelle, who has been already spoken of as among the early investigators of the chemistry of the urine, found that hydrochloric acid precipitated from the urine of the cow after evaporation a salt which he compared to the flowers of benzoin. It is now more than twenty years since Liebig showed that this precipitate is either benzoic acid combined with animal matter, or an acid of an altogether peculiar character. This chemist even then adopted the latter view, and termed the new acid, as being found in the urine of the horse, hippuric acid. Berzelius, at the same time, considering that it exists generally in the urine of herbivorous animals, preferred giving it the name of urobenzoic. It occurs combined with soda or ammonia in the urine of the horse and cow; from the urine of these animals it is obtained by boiling with an excess of milk of lime, straining, boiling down the clear liquid to one-tenth of its original volume, adding so much hydrochloric acid as to produce an acid reaction, and setting it aside to rest, when coloured hippuric acid is deposited in crystals. Though Liebig has carefully proved its existence in human urine, the quantity present appears to be too small to admit of its being easily detected. After purification, the hippuric acid forms long transparent or milky-white, four-sided prisms acuminated on two faces, having a slightly bitterish taste ; it reddens litmus paper, and melts when heated, but concretes into a crystalline mass on cooling.



HIPPURIC ACID CRYSTALS.

A high temperature decomposes it, when benzoic acid and benzoate of ammonia distil over in red oily drops, which have a strong and agreeable odour of tonka beans, and become solid. Hippuric acid is soluble in 400 parts of cold water, but is easily dissolved at a boiling heat. Nitric acid converts it readily into benzoic acid. The same change is effected by boiling with muriatic acid. If gently heated with hyper-oxide of manganese and sulphuric acid, it is redissolved into carbonic acid, ammonia, and benzoic acid. If the urine of the horse or cow be left to itself for a long time, or be evaporated at a boiling temperature, it yields not a trace of hippuric acid, but only benzoic acid. The same thing occurs if the animal be hard worked; hence to obtain hippuric acid, the urine of stall-fed animals is taken.

Urine which contains an excess of hippuric acid is for the most part either slightly acid or neutral, often alkaline. Deposits of the triple phosphate of magnesia are not unfrequently seen in such urine. When present in unusual quantity it may be detected in the human urine by filling with it a large watch-glass and evaporating over a lamp to a few drops; half the bulk of hydrochloric acid is then to be added and the mixture to be set aside. When the acid is added the mixture becomes bright pink, and an odour resembling that of new hay is perceived. In a few hours the characteristic linear crystals of hippuric acid will be discovered. To remove all doubt, a portion of these crystals may be dissolved in water or in alcohol, and on placing a drop of the solution on a plate of glass beautiful crystals, discoverable by the microscope, will be obtained after the evaporation of the fluid.

When hippuric acid occurs to excess in human urine it commonly depends on peculiarities of food. It was traced in one case to a long confinement to a milky diet; in another to the almost exclusive use of apples. It does not appear to interfere in man with the production of uric acid. But for the most part there appears to be a deficiency of urea when hippuric acid is present. It has been observed to co-exist with albumen in the urine. Dr. Garrod has detected hippuric acid in the blood. Mr. Ure has advised the use of benzoic acid in the belief that by its metamorphosis into hippuric acid it can destroy the alkaline condition of the urine.

Creatine and Creatinine.—Creatine is a crystalline substance first noticed by Chevreul in the juice of the flesh of animals. It appears to be a product of the metamorphosis of muscular tissue under the influence of destructive assimilation. When an ounce of urine is evaporated to the consistence of syrup, and the clear fluid poured off from the deposited salts, then a small piece of fused chloride of zinc added, the fluid being at the same time warmed, and then set aside for twenty-four hours, a deposition of minute granular crystals takes place. These crystals consist of a triple compound of zinc and chlorine with creatine and creatinine. Under the microscope these crystals have quite a peculiar aspect. (*Golding Bird, Urinary Deposits*, pp. 4 and 34.) These substances were first discovered in the urine by Dr. Pattenkofer. Creatine occurs in colourless transparent lustrous rhombic crystals, is perfectly neutral, and crystallizes from its solution in tufts like acetate of lead. These crystals contain 12 per cent. of water, are soluble in 74 parts of cold water, and are nearly insoluble in strong alcohol. Creatine contains, when dry, nearly 32 per cent. of nitrogen. Creatinine contains as much as 42 per cent. of nitrogen, and differs from creatine in possessing a highly alkaline re-action. It is soluble in about 11 parts of cold water and about 10 parts of cold alcohol; from its aqueous solution it crystallizes in small prisms. It forms salts with acids. According to the most recent views these substances are excrementitious, and it is probable that a considerable portion of creatine is resolved into uric acid or urea before its final elimination. (*Golding Bird, ib.* p. 93.)

Mucus; Epithelial Debris.—A portion of mucus derived from the bladder and urinary passages is invariably present in the urine. The morning urine of health, however, is the best adapted for exhibiting this substance.

When the urine, after being allowed to rest, is held between the light and the eye, a delicate cloud is observed, and if this urine be passed through a paper-filter, the mucus will form upon it a thin layer like varnish. The proportion of mucus in the urine varies considerably under different circumstances. At one time it shows a remarkable flocculent cloud, at another time it renders the urine so viscid that it may be poured from one vessel into another in the form of a tenacious cord. When a portion of this mucus is placed under a microscope it exhibits distinct mucous granules and epithelial cells. It has been observed that urine abounding in mucus is generally alkaline, and soon undergoes putrefaction. This is an important fact, since for the production of alkaline urine, all that seems requisite is that it should be retained in the bladder for a longer time than usual. It has been commonly supposed that alkaline urine is among the symptoms of spinal disease; but it is to be remarked that owing to the paralytic state attendant on such a disease the bladder is often imperfectly evacuated, and therefore decomposition, with the production of ammonia rendering the urine alkaline, takes place before it is discharged.

Dr. Bence Jones makes the following observation; "I know that a great cause of this change (the alkalescence of the urine) is the presence of mucus which is secreted by the mucous membrane of the bladder, and this may be considered as the ferment or cause of change in the urine. More or less of this substance may be always found to be present. To show its influence I took equal quantities of the same urine; one portion I filtered through very fine filtering paper, the other portion remaining as it was passed. Both quantities were exposed to similar influences as regarded temperature, position, &c. Both remained aside until the 11th day, when the filtered portion was acid and the unfiltered was neutral; on the 12th the filtered portion was acid, the unfiltered was alkaline; on the 15th the filtered was acid, the unfiltered was alkaline; on the 16th the filtered was alkaline, the unfiltered was highly alkaline." (*Bence Jones on Animal Chemistry*, p. 89.)

The essential cause of an increase in the quantity of mucus in the urine is the presence of irritation of some kind in the passages. Of these irritations there is an excellent example in the presence of a urinary calculus. Sometimes it is dependent on an inflammatory affection of the mucous lining of the bladder, and is often attended with a great increase in the proportion of phosphates in the urine.

The treatment of such an affection must vary according to the circumstances of its origin; not unfrequently astringents, the uva ursi, the chimaphila, buchu, and pareira brava have proved serviceable.

Non-azotized Substances ; Colouring Matters.—When a test-tube is filled to one-third with urine, boiled over a lamp, and a fourth part of its bulk of hydrochloric acid added, a fine pink or purple colour is produced depending on the separation of the peculiar colouring matter of the urine. (*Golding Bird, ib.* p. 5.) This pink pigment dissolves easily in weak hot alcohol, communicating to it a yellowish pink colour ; it unites also very readily with urate of ammonia. For this pigment Dr. Golding Bird proposes the name purpurine ; and he conceives it to be identical with what Simon calls uroerythrine and Heller uroxanthine.*

Fatty Matter.—It may be doubted if in healthy urine oily or fatty matter be ever present. It is, however, described. The microscope affords the best means of distinguishing the presence of fatty globules. The film on the surface of decomposing urine, instead of fatty globules, exhibits, under the microscope, an amorphous granular matter. Cases have occurred in which the urine has contained so large a quantity of fat that the oily vesicles could be observed even with the naked eye, and formed a principal stratum on the surface. It was to fatty urine that Dr. Prout applied the term chylous. From the researches of Dr. Eichholz and of Dr. G. Johnson, it appears that fatty matter not only exists in abundance in the urine of granular disease of the kidney, but is even pathognomonic of that affection, or at least of one of its most frequent forms.

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* Dr. Parkes, of University College, has stated that the substance termed uroxanthine by Heller, and from which are derived uroglaucin and urrhodin, is in reality a biliary colouring matter present in the urine, and this statement appears to be confirmed by a late observation of Heller, who found on the mucous membrane of the intestines and in its follicles in persons who died of cholera, blue microscopic crystals identical with this uroglaucin.

Salts of the Urine.—According to Liebig, the incombustible parts of the blood, that is to say its saline matter, when all that is variable or accidental is left out of view, are the same, at all times, and under all circumstances, in all animals. These invariable incombustible substances consist of phosphoric acid combined with the alkalies, potash and soda, and with alkaline earths, lime and magnesia, oxidized iron, and common salt, or chloride of sodium: these same substances are the incombustible matters of the food. If the food fails, or fails to contain a sufficiency of these incombustible substances, then the same substances fail to appear in the blood. While the body continues in health, and is neither gaining nor losing in weight, these incombustible substances do not accumulate within the living system. The quantity of such matters thrown off equals the quantity which is received into the body within a given time. And there are two principal if not exclusive channels by which these incombustible substances are thrown off, viz., the intestinal canal and the kidneys. In all animals the blood is alkaline, notwithstanding that it always contains phosphoric acid, the acid being neutralized by an excess of alkali,—for example, of soda. The blood of vegetable feeders contains a much less proportion of phosphoric acid than the blood of carnivorous animals, and yet, as regards the proportion of the above-named incombustible substances present in the flesh of these two orders of animals, there is no perceptible difference. Thus in the vegetable feeders a less proportion of phosphoric acid is made to serve the same purpose in the nutrition of the solids as the larger proportion present in the blood of carnivorous animals. While, however, in the blood of vegetable feeders phosphoric acid is present in smaller proportion, carbonic acid is discovered in much larger proportion. And, singular as it may appear, there are many remarkable points of analogy between carbonic acid and phosphoric acid. Thus phosphoric acid unites with soda without destroying the alkalinity of the compound, as carbonic acid unites with that base, while the compound retains an alkaline reaction. Again, the solution of an alkaline phosphate, like the solution of an alkaline carbonate, can take up a large proportion of carbonic acid, which readily separates from the fluid on agitation or exposure to the atmosphere. And the insoluble earthy phosphates become dissolved in water containing carbonic acid as happens when an excess of phosphoric acid is present. The urine of man and of carnivorous animals has always an acid reaction, and this acid reaction, according to Liebig, depends on the alkaline phosphate of the blood having been deprived of a portion of its base, by the acids produced from the blood such as the uric. The urine of vegetable feeders has no acid reaction, since the carbonic acid which replaces so large a proportion of the phosphoric acid in their blood, unites with the earthy bases, lime and magnesia. The same author affirms that when the diet of man is exclusively vegetable, carbonic acid replaces a part of the phosphoric acid of the blood, and that on the same condition as in vegetable feeders the urine ceases to be alkaline. He regards the acids which abstract a portion of the base from the phosphates, viz. the sulphuric, the uric, the hippuric, as being the result of a true combustion within the body.

Sulphates.—No fact in chemistry is better established than the existence of sulphur in the blood : nor is its existence less certain in urine. There is, however, this remarkable difference between the two :—in the blood very little is in the state of sulphuric acid ; while in the fluid derived from the blood and passed by the kidneys, the greater part of the sulphur is found to be oxidated to its maximum—that is, converted into sulphuric acid—and neutralized. The question then arises, Whence is the requisite oxygen supplied ?

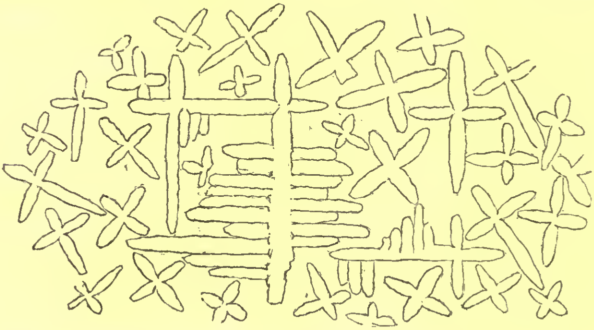
During the circulation of the blood through the lungs, one of the changes there effected is the conversion of part of its carbon into carbonic acid, which is expelled with the breath. In that case, the necessary oxygen being derived from the air in respiration and not by the skin, it might be asked whether, at the same time, there may not be a surplus of oxygen gas taken up and retained in the blood for appropriation in the glands, and particularly in the kidneys ? The experiments of Allen and Pepys (Phil. Trans. 1807-8-9) ascertained a fact which decides that question. They proved that the oxygen received by the lungs is all again expired, including that portion of it which is formed into gaseous carbonic acid. The oxygen, therefore, for the acidification of sulphur within the kidney, must be derived from the blood itself; and probably from substances contained in it, but of no further use in the animal economy. But the decomposition of these substances, by the abstraction of part of their elementary oxygen, must convert them also into new compounds. In this way, possibly, that highly azotized body, urea, may be formed; for it seems improbable, in a healthy condition of the glands, that a substance of excrementitious character should be created immediately from the albuminous portion of the blood, unless in cases where albumen is formed in excess.

It has been a controverted question, whether urine contains sulphur in any other state than that of sulphuric acid. Berzelius was the first to show that it does, because after acidulation with muriatic acid, and precipitation with muriate of barytes in very slight excess, and then decanting the clear supernatant liquid, there still remains in perfect solution some combination of sulphur, which may be detected by evaporating to dryness along with nitrate of barytes, and incinerating the residuum. In that residuum, sulphate of barytes was discovered by Berzelius. The experiment may be advantageously varied, by substituting pure nitrate of potash for nitrate of barytes before the incineration. The ash being afterwards dissolved in a few drops of water acidulated with muriatic acid, yields with muriate of barytes a precipitate, which is the sulphate: not a mere trace, but an appreciable quantity.

This requisite destruction of the organic matter, for the purpose of detecting the last portions of sulphur, applies equally to the analysis of blood, in which even the iron otherwise escapes the action of chemical reagents. It was on that account that Berzelius inferred that these and several other substances in the blood exist in some state unknown to us, and certainly not as salts. Engelhart combated the opinion of Berzelius, by showing that these various bodies might be detected without incinerating the blood, provided it were acted upon by chlorine. But the chlorine may liberate oxygen to oxidize the sulphur, iron, &c., by seizing upon the hydrogen of the organic matter, or even of the water, and this is so obvious that it is almost a wonder it should have escaped those writers who adopt the views of Engelhart.

In the original analysis of the urine, published by Berzelius, the salts, sulphate of potash, and sulphate of soda, are stated as being present in considerable proportion. In all the more recent analyses, the sulphate of potash is still retained in nearly the same quantity. The sulphate of soda, however, is commonly omitted. In some analyses, however, for instance, in that by Lehmann, alkaline sulphates are set down to the extent of one-ninth of the whole solid residue. Whatever doubts, therefore, may be entertained as to the presence of sulphate of soda in normal urine, it is quite certain that sulphate of potash is present in considerable proportion. In some of the analyses, for example, in that of Dumeril, sulphate of lime is enumerated. The quantity of sulphuric acid present in these salts is plainly greater than could possibly have been introduced into the living system along with the food; it seems clear, then, that a great part of this sulphuric acid arises from the combustion of sulphur within the body. The presence of sulphates in the urine is usually proved by the common test; a little nitric acid is first added, and then nitrate of barytes; the white precipitate thrown down can be shown by the usual steps to be sulphate of barytes.

Chlorides.—Chlorine, as such, is never developed in animal bodies. Where it exists in them, it is usually in combination with sodium, forming common salt; but sometimes also, in minute quantities, with potassium, forming the chloride of that metal. It also exists in union with hydrogen and ammonia, forming common sal-ammoniac. All these neutral combinations are held dissolved in the urine, and never constitute morbid deposits, because neither with lime, magnesia, nor with any other elementary substance present there, does chlorine form an insoluble precipitate. If, however, free muriatic acid, of which chlorine is an elementary part, be habitually evolved within the stomach, as in dyspepsia, one of the consequences may be the formation of calculi, by the precipitation of the lithic acid, which the urine should retain in solution. Chloride of sodium is easily recognized by its cubic crystals when it can be obtained free from foreign substances; but as it crystallizes from the urine, it usually exhibits very remarkable forms. It has been found that common salt possesses the property, quite unusual among salts, of forming with urea a chemical compound, which crystallizes in beautiful large clear rhombic prisms. "Even," says Liebig, "in the vitreous humour of the eye the urea is accompanied by common salt, and the presence of the compound of urea with common salt in the urine of man and animals is the reason why we often obtain no nitrate of urea from urine moderately concentrated, and while in that which is more concentrated, there is left after the addition of nitric acid more urea in solution than corresponds to the solubility of the nitrate."—*(Familiar Letters on Chemistry by Justus Von Liebig,* 3rd edition, pp. 407-8.) The crystals of chloride of sodium modified by the presence of urea are usually represented as having the form of crosslets and daggers, crenate at the margins.



CRYSTALS OF CHLORIDE OF SODIUM.

Phosphates.—Phosphorus, unlike sulphur, exists only in the state of acid, that is, oxidated to its maximum: at least, it has not been found in any other state in healthy urine. The acid is but partly neutralized by the bases present.

The connexion of phosphorus with the animal economy is interesting, because it forms an essential constituent of the earthy part of bone, fully four-fifths of which consist of phosphate of lime. It is the phosphate of lime, too, which, becoming deposited within the bladder, forms one species of urinary calculi. There is another urinary calculus in which the phosphoric acid is combined with magnesia and ammonia, usually called the "triple phosphate"; and sometimes both these phosphates are present in the same stone, constituting a third species, denominated the fusible calculus. The formation of these particular deposits is attributed to a deficiency of free acid in the urine.

In Berzelius's analysis, the phosphate of soda, the biphosphate of ammonia, the phosphate of lime, and the phosphate of magnesia are enumerated. In some of the more recent analyses of the urine, the phosphate of ammonia is omitted. Dumeril, however, mentions the phosphate, and Marchand the biphosphate of ammonia. When free ammonia is added to fresh urine earthy phosphates are immediately deposited, and when lime water is added to this urine, after the earthy phosphates have been removed by filtration, phosphate of lime derived from the alkaline phosphates is precipitated. The alkaline phosphates are freely soluble in water; the earthy phosphates are insoluble in water, unless when there is an excess of phosphoric acid. The earthy phosphates, however, are soluble, when certain acids are present in the water; for example, the nitric, the hydrochloric, the acetic, and the lactic; and hence, when free acid is present in the urine, the earthy phosphates remain dissolved. The phosphates constitute a family somewhat intricate in their chemical characters and constitution. For example, there are salts of this family, in which one equivalent of phosphoric acid is combined with three equivalents of base, or with two equivalents of one base and one of another, or with three equivalents of different bases, and water, or the oxide of hydrogen, in this case, may be a base. "For example, we have a compound in which one equivalent of phosphoric acid is combined with two equivalents of water and one equivalent of soda. This substance is called acid phosphate of soda; it has an acid reaction, and it is a tribasic salt; or we may have a compound, in which one equivalent of phosphoric acid is combined with one equivalent of water, and two equivalents of soda. This is the common phosphate of soda. It has an alkaline reaction, and it is also a tribasic salt. Lastly, we may have a compound in which one equivalent of phosphoric acid is combined with three equivalents of soda. This is alkaline phosphate of soda. It has a stronger alkaline reaction than the previous salt, but it is not more tribasic. There are three bases in each of the three salts, whether there be three equivalents of soda, or two of soda and one of water, or one of soda and two of water, makes no difference, so far as the tribasic properties of the phosphoric acid are concerned. All these three salts, when in solution, give a yellow precipitate with nitrate of silver."—(*Bence Jones, M.D., on Animal Chemistry*, p. 78.)

The phosphates of soda in the urine are the most abundant. The earthy phosphates as regards quantity are of much less importance. Hence as to quantity, if we speak of phosphates in the urine, we ought to limit that term to the alkaline phosphates, and not apply it to the earthy phosphates alone. The amount of earthy phosphates precipitated when the urine becomes alkaline is solely dependent on the amount of the earths present; that is on the quantity of lime and magnesia passing out of the system.

Dr. Bence Jones, on this subject, arrives at the following conclusions:—

1. The variations of the earthy phosphates are so dependent on the earthy matter (lime and magnesia) present in the urine, that no deduction from them as to the nature or state of the disease is possible.

2. Neither the earthy phosphates nor the alkaline phosphates are permanently increased in spinal diseases.

3. In fevers and acute inflammations of fibrous, muscular, or cartilaginous tissues, the total amount of earthy and alkaline matter is not increased.

4. In chronic diseases in which the nervous tissue is not affected, no deduction can be drawn.

5. Chronic cases of mania, melancholia, and general paralysis of the insane, gave no marked results.

6. In chronic diseases of the brain, and in chronic and even acute disease of the membranes, there is no increase in the total amount of earthy and alkaline phosphates.

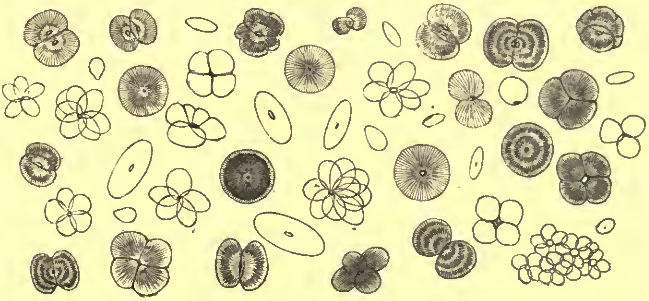
7. In fractures of the skull, when any inflammation of the brain comes on, there is an increase of the total amount of phosphates. When there are no head symptoms, no increase of the phosphates is observed, even when other acute inflammations supervene.

8. In acute inflammation of the brain, there is an excessive amount of phosphates in the urine. When the inflammation becomes chronic, no excess of phosphates can be shown to exist in the urine by the method of analysis that was employed.

9. In some functional diseases of the brain an excessive amount of phosphates is observable: this ceases with the delirium. Delirium tremens shows a remarkable deficiency in the amount of phosphates excreted, provided no food is taken. When food can be taken the diminution is not apparent.

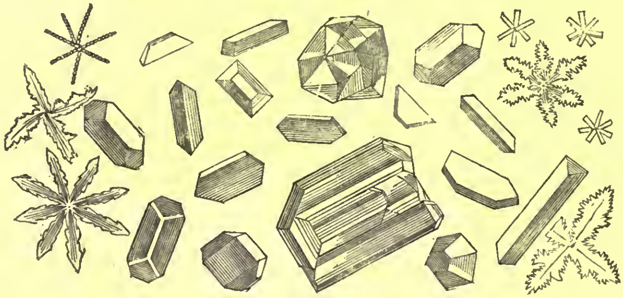
Carbonate of lime, fluoride of calcium, silicic acid.—If to urine, derived by filtration of its vesical mucus, an excess of caustic ammonia be added, a very bulky precipitate is thrown down. This precipitate (besides a minute quantity of ammonio-phosphate of magnesia) contains the lime in union with phosphoric acid. The supernatant fluid, if evaporated to dryness and incinerated, will be found to yield no more lime; whence it is obvious that if, according to Berzelius's experiment, calcium exists in blood in some other state than lime, this metallic base must become oxidated during its excretion by the kidney. Lime is a principal constituent of several kinds of urinary calculi, two of which have been already mentioned. There is a third, the oxalate of lime, or mulberry calculus. Where it does not result from the peculiar character of the food, the occasion of this morbid deposit is the formation of oxalic acid in the living body; possibly from some undue oxidation of carbon within the kidney. So strong is the affinity between lime and oxalic acid, and so great the insolubility of the resulting compound, that the addition of a very minute quantity of oxalic acid occasions in the urine a precipitate of oxalate of lime; because the oxalate, unlike the phosphate of this earth, is not (or at least not to the same extent) soluble in the natural acid of the secreted fluid.

Carbonate of lime, may occur, according to Liebig, in normal urine, when the diet of man is confined to certain vegetable substances. A trace of fluoride of calcium has been detected by most chemists in their analyses of the urine. The same may be said of silicic acid. In the majority of cases, carbonate of lime forms an amorphous deposit, mixed with prisms of ammoniaco magnesian phosphate. More rarely, it is met with regularly crystallized, in compound spherical crystals, like close-packed needles radiating from a common centre.



CRYSTALS OF CARBONATE OF LIME.

Magnesia.—It is but in small proportion that this earth is found in urine, from which it is precipitable in the state of ammonio-phosphate, along with the phosphate of lime, on the addition of ammonia. A portion, however, of the magnesia remains some time longer in solution ; such is the case when the carbonate of ammonia is employed. If, therefore, immediately after the addition of this reagent, the fluid be filtered, and then allowed to remain two or three days, there will form a few sparkling crystals of the ammonio-phosphate of magnesia. After removal of the magnesia from the solution, no more of it can be discovered by evaporation and incineration. No magnesium, therefore, exists in urine, except in an oxidized state. Magnesia, like lime, in combination with phosphoric acid, is one of the constituents of bone earth ; but it forms a very small part. As before stated, it is also a principal ingredient of certain urinary calculi, into which it enters. These are the "triple phosphate," or ammonio-phosphate of magnesia ; and the fusible calculus, consisting of that salt and the phosphate of lime. The triple phosphate presents various appearances under the microscope, some of the crystals being triangular and quadrilateral prisms, others stellated or penniform.



TRIPLE PHOSPHATE CRYSTALS.

ABNORMAL STATES OF THE URINE.

Having thus briefly considered the urine in its healthy state, I pass to the consideration of its abnormal conditions ; and first of

Albuminous urine.—Healthy urine does not contain albumen, being coagulable neither by heat nor by acids. Albuminous urine contains much less urea than healthy urine, and in these cases it is that healthy urea is found in the blood. This kind of urine is not characterised by any particular physical appearance; it often is of a natural colour, sometimes a little pale, at other times it is obviously tinged with blood. For the most part, albuminous urine is transparent at the instant it is voided, but on cooling it becomes turbid; its odour is ordinarily less urinous than the urine of health. When albumen is present in the urine, there are many tests by which it may be detected. If it is abundant, a scum forms on the surface when the urine is heated; and most strong acids cause the albumen when present to coagulate. The common tests, however, at present, of albumen in the urine are heat and nitric acid; for if a few drops of nitric acid be added to the urine containing albumen, a precipitate is formed, which we cannot re-dissolve by an excess of the acid, but which is readily dissolved by the addition of a sufficient quantity of an alkali. Heat, from its property of quickly coagulating albumen, is an excellent test for recognising this principle, as it has the advantage of not coagulating the other elements of urine. Albuminous urine, on being exposed to a temperature of about 150°, becomes opaque, and deposits the principle in a coagulated state. The precipitate varies considerably in appearance in different instances, being sometimes firm, and similar to that formed by the serum of the blood, from which it may then be supposed to be derived; while, at other times, it is delicate, fragile, and somewhat resembling curd, when it may be supposed to be of chylous origin. When the quantity of albumen present is not very abundant, some nicety is required in the application of these tests to avoid fallacies. Thus heat sometimes causes a milkiness of the urine in consequence of a deposit of earthy phosphates; this milkiness, however, is removed by a drop of nitric acid. If nitric acid be used alone in too large a quantity, it may redissolve the compound which the first portion of it formed with the albumen. Again, it is found that the presence of a small proportion of acid prevents the effect of heat in the coagulation of the albumen: also if urea be present in unusual abundance, the addition of nitric acid might at once cause a precipitate by the formation of nitrate of urea; in other cases the addition of nitric acid might cause a precipitation of urate of ammonia. These fallacies, however, for the most part are easily avoided. If heat causes a deposit in urine which is not removed by a drop or two of nitric acid, it is almost certain that albumen is present. Dr. Bence Jones says, "for quickness I generally try nitric acid first. If no precipitate falls or forms on standing for a few seconds, I decide against the presence of albumen. If there be a precipitate, I boil the same acidulated specimens of urine. If the precipitate be permanent on boiling, I consider the presence of albumen highly probable. Before I decide, I clean the tube and boil the urine first and then add a drop or two of nitric acid. The object of cleaning the tube is to free it perfectly from acid, for a small quantity of acid hinders the coagulation of albumen by heat. * * * * I have many times known an unclean test tube, containing merely a trace of strong acid, lead to the assertion that urine contained no albumen, when a very considerable quantity really was present. * * * Instead of filling the test tube with urine, it is well to take about a drachm of urine, filtered, if it be not previously quite clear; that is, if any cloudiness at all is perceptible, the urine ought to be first filtered; then the clear liquid should be boiled for a minute, and afterwards two drops of nitric acid should be added." When albuminous urine is alkaline, it is sometimes incapable of being coagulated by heat. It was supposed that this depended on the presence of some fixed alkali, holding the albumen in solution. Dr. Rees made an analysis of two different specimens of urine taken from the same individual: one was neutral, and coagulable by heat; the other was not so coagulable, and was capable of alkaline reaction. From analysis, it appeared, that the alkaline specimen contained a greater proportion of albumen, and a much smaller proportion of alkaline salts, than the neutral urine. This goes strongly, he observes, against the probability of any fixed alkali being the solvent of the albumen; for in this case we should expect a redundant quantity of fixed saline matter in proportion to the albumen present, whereas exactly the opposite was the result. The bichloride of mercury, alcohol, and tannic acid, and infusion of galls, have been employed as tests for albumen, but they cannot be depended on.

In the next place, it is of much importance to determine under what circumstances albumen has appeared in the urine. For this purpose the aid of the microscope is requisite. Albumen may co-exist in the urine with blood-globules, fibrine-globules, and pus-globules, and neither of these can easily be distinguished except by the microscope. If, however, a portion of the urine, determined to contain albumen, be left at rest for twelve hours, sometimes a distinct line of red globules is discovered at the bottom of the vessel. This, however, happens only when the quantity of blood-globules is considerable. It is an important fact that blood-globules are hardly ever discovered in the urine, except when albumen can be detected in it by heat and nitric acid. The co-existence of fibrine with albumen in the urine cannot be discovered except by the microscope. When the fibrine assumes the form of the urinary ducts of the kidney, albumen being at the same time present with or without blood-globules, it is a certain indication of congestion of the cortical structure of the kidneys, most probably connected with Bright's disease, or as a sequel to scarlet fever. When blood-globules are found without fibrinous casts, it is unlikely that the abnormal character of the urine is connected with congestion of the kidney. It is more probably the result of a calculus in the bladder or some part of the urinary passages, and this conjecture will be confirmed, if crystals of uric acid or oxalate of lime be discovered at the same time. When pus-globules are met with in the urine along with albumen, suppurative inflammation is certainly going on somewhere. If there be fibrinous moulds at the same time to be seen, the seat of the inflammation may be referrible to the kidney, being probably co-existent with Bright's disease. If no fibrinous moulds can be detected, it is not unlikely that a calculus has produced suppurative inflammation in some part of the mucous membrane. Fibrinous moulds, blood-globules, pus-globules, albumen, and crystalline deposit may all be discovered at the same time in the urine, and then it may be predicted that degeneration of the kidney, inflammation, and calculus will be discovered after death. —(*Bence Jones, ib.*)

It has been well remarked that the presence or absence of albumen in the urine is a sign of the greatest importance, because, as a general rule, if it be not found, neither fibrine, pus, nor blood can be present.

Pus.—Pus in the urine, to which I shall more fully allude in its proper place, indicates suppuration at some part of the urinary canals. Pus must be distinguished from mucus. In pus-globules active nuclei are almost always to be found; that is, young pus-cells growing within the old ones. Mucus does not multiply; the cell is slightly granular only. With mucous exudation, globules do not occur; with pus they are constantly found.

Blood is often poured out in abundance from the mucous membrane lining the urinary passages, and is generally diffused through the urine, or is passed entire. In other cases small quantities of blood are passed, mixed with pus or mucus, or alone, after the urine has been voided. When large quantities of blood are passed, especially without pain, it is probably a simple exudation from some part of the mucous surface of the urinary organs; on the other hand, when the blood is mixed with pus or mucus, and passed with pain, it denotes ulceration of the kidney or bladder, and may be combined with the existence of a foreign body in the bladder.

Dr. Willis, and other writers, quote several authorities to show that hæmaturia is endemic in some countries. M. Chapotain,* for instance, informs us that, in the Isle of France, children from their earliest infancy are liable to hæmaturia, without suffering either pain from it, or prejudice to their general health. M. Salesse,† a native of the Isle of France, and now a practitioner of medicine there, states that three-fourths of the children are affected with hæmaturia at one time or another. In these cases the bloody urine is generally observed to alternate with that which is chylous or oleo-albuminous. During the invasion of Upper Egypt by the French, many of the men suffered from an epidemic hæmaturia.‡

Spermatozoa.—Spermatozoa are discoverable in the urine at times by the microscope, and are recognised by their peculiar form. Most commonly they are present without the co-existence of albumen, but Dr. Bence Jones refers to a case in which they were present while the urine was highly albuminous.

Cystine.—Cystine does not belong to healthy urine, and is not very often found in the diseased secretion. It was first discovered by Dr. Wollaston in a calculus given to him by Dr. Reeve of Norwich. Its chemical composition is remarkable; besides the common elements of organic animal bodies, carbon, hydrogen, nitrogen, oxygen, it contains so large a proportion of sulphur as twenty-six per cent. It has not been recognised till lately as a constituent of morbid urine. It forms a nearly white or pale fawn-coloured pulverulent deposit, much resembling the pale variety of urate of ammonia. The urine containing it, when first passed, is commonly turbid, and after a time deposits the cystine. Pure cystine is dissolved by the mineral acids, and forms with them saline combinations. It is easily dissolved by ammonia, but is insoluble in the solution of carbonate of ammonia; it is dissolved, however, by solutions of the fixed alkalies, as well as of their carbonates; when heated on platinum foil it can be made to burn while it evolves a disagreeable smell. The microscopic characters of cystine are so striking and peculiar as to render the use of tests unnecessary. The hexagonal plates are beautifully shown when the solution in ammonia is allowed to evaporate spontaneously.

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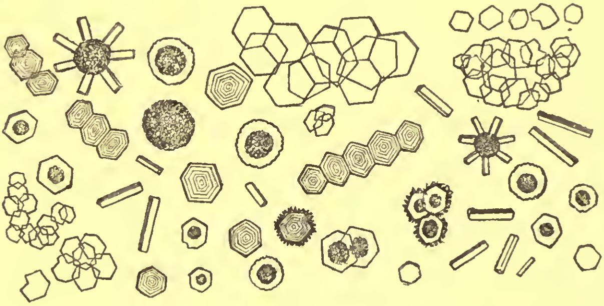
* Topographie Méd. de l'Isle de France. Paris, 1812.

† Diss. sur l'Hématurie, Théses de Paris, 1834.

‡ Renoult, Notice sur l'Hématurie, &c., in Journ. de Méd. tome xviii.



MICROSCOPIC APPEARANCES OF CYSTINE.

Uric oxide, or xanthic oxide.—Uric oxide, or xanthic oxide, has also been termed xanthine, uric oxide, and urous acid. It was first met with by Dr. Marcet in a minute calculus which was made up entirely of this substance. But to uric oxide, a substance obtained from guano, termed guanine is closely allied; also the substance which Scherer has termed hypoxanthine. Uric oxide dissolves slowly in nitric acid, and the solution on evaporation leaves a yellow residue.

Kiestein.—Some years ago Nauche announced the discovery of a peculiar substance in the urine of pregnant women to which he gave the name of kiestein. He describes it as a white mass, which after the urine has stood for some time separates, partly rising to the surface, where it forms a somewhat tough pilous membrane interspersed with glistening crystals, and partly sinks to the bottom, forming a creamy precipitate. He regards kiestein as an indubitable sign of pregnancy. Many chemists have applied themselves to the investigation of this subject, but some uncertainty still surrounds it. It is, however, probable that it is nothing but a small quantity of fatty matter mixed with phosphates, and that it is not peculiar to pregnancy.

Sugar.—In healthy urine no sugar is found. Sugar, however, is plainly formed from starch in the process of digestion, and is well known to be abundant in at least one healthy secretion, viz. the human milk. The sugar of milk is not exactly the same as the sugar of morbid urine, but does not differ very much from it in chemical constitution. In the process of digestion, starch appears to pass under the influence of the hydrochloric acid of the gastric juice into dextrine, and subsequently the dextrine into sugar. The sugar found in morbid urine is the same as that found in grapes, to which chemists have applied the name grape sugar. It differs considerably from the sugar of the sugar cane. Hitherto sugar has been met with chiefly in diabetes and is regarded as a sign of true diabetes, even although it is sometimes found in small quantities in persons who are not diabetic; in this case, however, its presence is only temporary, and the quantity so small as not to affect the specific gravity. It seems not impossible that sugar should sometimes be present in derangements of a less serious character, though its presence in any other affection besides diabetes has not yet been ascertained. Bernard has stated, though the statement has not been confirmed, that if a certain spot in the fourth ventricle of the brain of rabbits be pricked, in the course of an hour or two the urine and the blood will contain large quantities of sugar.

Numerous tests of sugar in the urine have been suggested of late years.

It may often be obtained in crystals by evaporating the urine to the consistence of an extract and digesting this extract with alcohol, on the evaporation of which the crystals form. A convenient test is that proposed by Mr. Moore of Birmingham. Two drachms of the suspected urine are placed in a test tube, and a drachm of liquor potassæ is added. The mixture is heated till it boils,—if sugar be present, the urine, which was previously pale, becomes of an orange brown, or even of a bistre tint, according to the proportion of sugar present. The solution of potash must be free from lead, otherwise a dark colour may be produced though no sugar is present.

The copper tests, however, of Trommer and of

Capezzuoli are more perfect. They consist in adding to the suspected urine, a solution of sulphate of copper, or of the blue hydrated oxide, the mixture being rendered alkaline by the liquor potassæ. In the one case we have a blue solution, and on boiling the mixture a deposit of red suboxide of copper if sugar be present, and in the other a reddish solution which in a few hours becomes yellow.

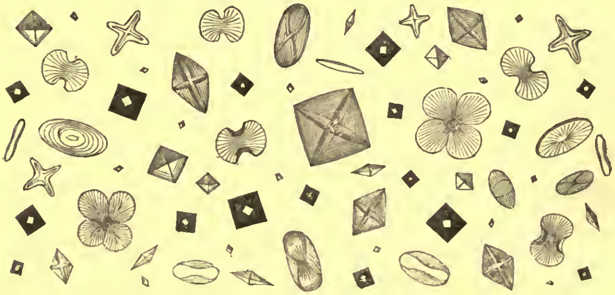
Dr. Bushnan, in the "Medical Times," (No. 443, Vol. XVII.,) describes the polariscope, a new instrument for ascertaining the presence of sugar in urine. It consists of a glass tube sixteen inches long, and capable of being hermetically closed at each end by means of a small plate of glass secured by a brass ring and screw. After having completely filled the tube with the fluid about to be examined, which is done by holding it vertically—taking care that no globule of air shall be introduced—and then closing it, a ray of linearly polarized light is made to traverse it, by fixing to its extremity, directed towards a white cloud, either a Nichol's prism, or a crystal of double refracting power, as a tourmaline cut parallel to its axis. A second prism, or a second tourmaline, fixed at the other extremity to which the eye is applied, permits us to see, through a circular division, in what degree the direction of the polarized ray is turned aside by the action of the liquid; and the angle thus formed is proportional to the length of the tube and to the quantity of active molecules, that is to say, to the density of the sugar, which seems to be the only active substance contained in the urine. As the fluid is generally high-coloured and of feeble action, it is not possible to observe the colours developed by the unequal action of the liquid upon the different particles of white light; and consequently it is unnecessary to employ Nichol's prisms, which, besides, are not always to be obtained. The two tourmalines are quite sufficient, provided they are not too highly coloured; and it is very easy to observe the total disappearance of the ray of light, when, by turning the eye-piece, the tourmalines are made to cross each other at right angles. In placing the tourmalines in this position before the introduction of liquid into the tube, the index of the circular scale attached to the eye-piece being at the same time placed at zero, no ray of light is seen, while the use of an active fluid causes it to reappear more or less distinctly. On slightly turning the eye-piece with its contained tourmaline either to the right or to the left —and as it is turned the angle formed is marked by the index on the scale—we find that at a certain point the former obscurity is re-established; and it is the angle obtained at the moment the ray of light disappears and the obscurity is complete, that determines the quantity of saccharine matter contained in the fluid.

A circumstance unfavourable to this kind of research is the commonly incomplete transparency of the urine, even after repose and filtration. Urine apparently limpid, when placed in the tube seems anything but clear; and a quantity of diffused light, mixing with that regularly transmitted, further impedes distinct vision; nevertheless, even when in some degree turbid, it is always possible, although with some indistinctness, to perceive the action of the ray transmitted through the tourmalines and saccharine urine.

This process Dr. Bushnan thinks much superior and far more simple than that recommended by M. Biot, employed by M. Bouchardat, and described by Dr. Golding Bird, to detect sugar in urine by its action on polarized light. The instrument is less complicated; and, besides which, saccharine urine is seldom sufficiently clear to allow the colours produced by circular polarization to become visible. Again, it is so far preferable to the usual modes of testing suspected urine that no long and complicated chemical manipulation is required; the presence of sugar can be ascertained at once, and, if needs be, in the presence of the patient; and, when ascertained, its increase or decrease can be determined during the progress of treatment, by the greater or lesser angle obtained by the altered direction of the polarized ray passed through the fluid—the greater the quantity of sugar, the greater being the angle indicated upon the scale.

The most convenient means of ascertaining the presence of saccharine matter in diabetic urine is to add to it some yeast, which gives rise to vinous fermentation,—a most delicate test, as it can detect one part of it in a thousand parts of urine. Every cubic inch of gas given off nearly corresponds in round numbers with one grain of sugar—47 of gas to 45 of sugar. This process, although simple of execution, yet requires certain precautions in order to avoid an erroneous result, as sometimes the yeast contains a small quantity of saccharine matter, which is decomposed during the fermentation, and might make one suppose that sugar existed in the urine although it was free from it. But the quantity of carbonic acid gas given off in this case is always very small. On the other hand, if the temperature to which the liquid is exposed be too high or too low, fermentation may then not take place, although the proportion of saccharine matter may be sufficiently great.

Oxalate of Lime.—It has been known for a long time that oxalate of lime constitutes the mulberry calculus, but it has not been observed till recently that this salt is of frequent occurrence in urinary sediments. To determine whether oxalate of lime be present in the urine, that should be chosen which has been passed a few hours after a full meal; a portion of it is to be put into a large test tube, and allowed to stand for some hours. The upper six-sevenths are to be decanted, then a portion of the remainder is poured into a watch-glass and gently warmed over a lamp,—the fluid is to be allowed to repose for a minute or two, and then the chief part of it is to be removed with a pipette and replaced by distilled water. A white powder, often of a glistening appearance, will now become visible, and this, under a microscope exhibits crystals of oxalate of lime in beautifully formed transparent octohedra, with sharply defined edges and angles, and other forms usually termed dumb-bells.



CRYSTALS OF OXALATE OF LIME.

Lehmann has recommended as the best method of detecting, in winter, small quantities of oxalate of lime in the urine, to expose it out of doors till it freezes. The ice first formed in the urine, as in the case of wine and vinegar, consists of pure water, so that by its removal a concentrated solution of the urine is obtained, and in this concentrated solution crystals of oxalate of lime are generally discoverable by the microscope.

Urine containing a considerable quantity of the crystals of oxalate of lime presents the following characteristics. It is strongly acid, of an amber or greenish yellow hue, perfectly transparent, has a high specific gravity, contains an excess of urea, readily crystallizing on the addition of nitric acid ; when heated it exhales, according to Dr. J. W. Begbie, a peculiar aromatic odour, resembling the sweet briar. Epithelium scales are sometimes present in the urine, which is then more or less turbid, If the urine be held up to the light, minute shining points may often be seen diffused through the fluid.

Lehmann, Höfle, and other chemists, have shown that oxalate of lime is always to be found in the normal urine of herbivorous animals, and not unfrequently in the normal urine of man. The presence of oxalate of lime in the urinary secretion has been conceived to indicate the presence of a peculiar morbid diathesis to which the name of oxaluria has been applied. There can be no doubt that this salt in the urine has frequently been connected with great derangements of health ; and it is equally certain that oxalate of lime may be found in the urine when no great derangement of the health exists; and it is also equally certain that it may be detected in the urine, in considerable quantities, when the derangements of the health for which relief is sought are of the most dissimilar kinds. The question then arises, Of what value, as a means of diagnosis and of prognosis, is the existence of oxalate of lime in the urine? To answer this question, we must be careful to separate from each other the cases in which the oxalate exists in small quantities, and for a short time only, from those in which it is found in large quantities and for a lengthened period of time;—to separate from each other those cases in which it is a passing symptom from those in which it is a constant abnormal excretion. And first of those in which its presence is temporary only. A dozen previously healthy men dine together, eat richer food in larger quantity than is their habit, and in addition drink pretty freely of sparkling wines or bottled ales. Let these men examine their urine the following morning, and a certain proportion of them will find that they have passed the beautiful octahedral crystals of oxalate of lime. Now let these *bon vivants* become for the next twenty-four hours total abstinence men, and then let each of them again examine his urine with the microscope, and the glittering evils will have vanished; they will have excreted not a particle of the salt which a few hours before affrighted them. The feast, the champagne especially, did its work; the food was imperfectly digested and badly assimilated, and, as a consequence, the blood deviated from its normal state, and oxalate of lime appeared in one of those excretions by which the life-holding fluid is depurated.

A man exposed to wet and cold has his system so affected that an attack of rheumatism is the consequence. Urate of ammonia is thrown out by the kidneys in large quantities, and amid its amorphous granules, crystals of oxalate of lime are found. Now, whether in this case the oxalate results from a change among the elements of urine—a change effected subsequently to its exit from the kidney, or whether it be, as in the former case, directly formed from the diseased blood, may admit of question; a question, however, to be decided by chemists, and not by those engaged in the practice of their profession. Still this much the practitioner knows, that in these cases its presence is temporary, and that practically it is of no value as a means of diagnosis or of prognosis.

How different from either of these cases is that of a man whose every look, whose every movement indicates mental depression. His complexion is dingy, or has a greenish yellow tint. He fancies himself the subject of every ailment that flesh is heir to. Now cancer, then phthisis; now threatening apoplexy, and then coming insanity. He cares no more for the pleasures of the world, and in mental exertion he has ceased to find joy. All around him appears flat, stale, and unprofitable; all within him is a barren waste. If he consults a surgeon, and the urine is examined, it is found of high specific gravity, acid, and in it crystals of oxalate of lime may be detected; but here they are to be found in considerable quantity, not only to-day, but every day, not for a week only, but for months, unless the patient be judiciously and successfully treated. On inquiry in such a case, as Dr.

Golding Bird has remarked, the sexual power is generally found defective. What is the primary disease in the case here drawn ? Disordered digestion and mal-assimilation ;—and to remedy these deviations from healthy action, the treatment must be directed. The presence of oxalate of lime in the urine is here a symptom ; but then it is a symptom of great value both with reference to diagnosis and to prognosis. Experience has taught us, that in such a case, although the patient may complain but little of dyspeptic symptoms, such as flatulence, pain after food, &c., yet the process of digestion is imperfectly effected ; we know, moreover, that the disease, although even it may be cured with difficulty and be liable to recur, will yet be rendered comparatively harmless by the administration of judiciously-selected remedies, and properly regulated hygienic and dietetic regimen. The warning afforded by the presence of oxalate of lime in the urine in such a case must not be neglected, or most serious consequences ensue. As Dr. Begbie* says, "if neglected or maltreated the malady will assuredly subject its victim to the sufferings and perils of stone in the kidney or bladder, or the still more serious consequences of malignant organic disease." He goes on to say, "Such are the miseries that flow from the diathesis,—from a poison generated during the process of digestion and assimilation, carried into the blood through the ordinary channels, but limited in its pernicious consequences by the busy agency of the urinary organs in separating it from the circulation and discharging it from the system. By this process of elimination we are enabled to detect the offending matter in the urine in the form of the oxalate of lime by tests at once simple and satisfactory, and are thus prepared with a plan of treatment equally simple and successful in mitigating the pains and miseries of the patient, and in gradually subduing and ultimately removing the diathesis which has been their lasting source."

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* Edinburgh Monthly Journal, August, 1849.

I will suppose another case. A man has had repeated attacks of winter cough—of bronchitis, and from its consequences pulmonary emphysema; his breathing is always more or less impeded; he is, as the vulgar say, "short-breathed." Now in the urine of this man will be found pretty constantly, as Lehmann observes, much oxalate of lime.

But not to multiply examples, the following are the chief points which the practitioner must bear in mind with reference to the occurrence of oxalate of lime in the urine.

1. The occasional presence of a few crystals is no indication of disease.

2. The ingestion of aliment containing oxalic acid is often followed by the excretion of oxalate of lime with the urine.

3. The occurrence of a large quantity of oxalate of lime in the urine, if on the preceding day the patient has indulged freely in the use of sparkling wines or ales, is of no moment.

4. Crystals of oxalate of lime are exceedingly common in the urine of those suffering from acute rheumatism, or other diseases attended with the excretion of urate of ammonia.

5. The urine of persons whose lungs are emphyse-

matous, or in whom from other causes imperfect oxidation of the blood is effected, pretty constantly contains the salt in question.

6. If the latter set of cases be excluded, the constant presence of oxalate of lime in the urine is a valuable sign of disordered digestion, and important as an indication of the treatment to be pursued.

There is one symptom due to the local action of the oxalate of lime with which it is essential the surgeon especially should be acquainted, as it is often present whatever may be the cause of formation of the salt, viz., irritability of the bladder. Too often is this cause of the so-called irritable bladder overlooked and the patient subjected to treatment which can never remedy the evil, while a little further examination of the cause by the surgeon would have enabled him to have quickly brought the case to a successful termination. The practitioner must also bear in mind that the presence of oxalate of lime in the urine of patients labouring under acute diseases is often indicative of the commencement of convalescence. Dr. Walshe of University College has quite settled this point, and has published very satisfactory tables in illustration. In 17 out of 19 acute and anæmic cases, crystals of oxalate of lime appeared in the urine at the commencement of recovery; and, as he remarks, their deposit may be regarded as the indication of its approach.

The treatment of cases in which oxalate of lime is detected in urine must vary with the cause of its origin. If it occur during the course or convalescence from an acute disease, then must the treatment be altogether directed to the relief of the disease itself, and conducted without reference to the presence of the salt in question; so, if it have its origin in the imperfect performance of the respiratory function, must its presence be regarded as of very trifling moment. The remedies employed must be those which improve the disease of the lung, so that by removing or alleviating the primary disease, one symptom of it—the oxalate of lime—may also be removed. Should the origin of the salt have been error of diet, the error must be corrected,—abstinence practised, a gentle aperient administered, and the cure will be effected. In those cases in which the oxalate is the consequence of chronic dyspepsia, it is the stomach affection chiefly which is to be treated. Daily exercise, if possible, should be enjoined, the patient being moderately warmly clothed. The amount of exertion must be such as to induce a very slight sense of fatigue. The food should be simple and not stimulating; plainly-cooked mutton and beef, with a moderate quantity of farinaceous or leguminous vegetables, should form the chief meal to be taken in the middle of the day. For breakfast, cocoa made by boiling the nibs with a considerable proportion of the milk left after the removal of the cream should be the drink, a lightly-boiled egg and dry toast the solids. Green tea is rigidly to be excluded from the patient's diet list. A little arrow-root made with milk and water, and dry toast should form the supper, to be taken about half an hour before retiring to bed. Early rising is as a rule advantageous, and the patient should, if possible, be asleep before eleven at night. Mental repose is essential for the well-doing of these often obstinate cases. Change of scene, by distracting the attention, and change of air, by invigorating the general system, exert a marked influence over the digestive organs. Stimulating drinks are to be avoided, the most to be allowed being a little weak brandy and water at dinner. As to medicines, the bowels must be regulated by gentle aperients; aloetics with tonics are perhaps the best, and for this purpose the extracts of gentian and aloes form a good compound. Should a clay colour of the stools indicate a sluggish action of the liver, then a very mild mercurial may be given two or three times a week—or a still smaller quantity of the mercurial, say half a grain of blue pill,—every night for a fortnight or three weeks. In some cases a chalybeate proves useful; the indication for the use of iron being the anæmiated condition of the patient. Hydrocyanic acid in full doses often affords considerable relief. Narcotics should be avoided, the irritable state of the patient too often leading to their injudicious administration. Nitro-hydrochloric acid, is sometimes of considerable service, as is also nitric acid. With reference to the nitro-hydrochloric acid, Dr. Golding Bird says, "they—that is the nitric and hydrochloric acids—should always be prescribed in the proportion of one part nitric and two or three of hydrochloric acid, with a direction for them to remain together at least a few minutes before being diluted to the proper extent for administration in medicine."

As a due performance of the function of the skin is essential for the healthy exercise of the digestive powers, tepid baths should be taken two or three times a week, either in the form of plunging or shower baths ; the skin immediately after being well rubbed by a coarse towel. Some patients derive benefit from cold shower baths, the test of their agreeing being the glow felt quickly after leaving them. If the patient feel chilly for some time after the bath, the surgeon must forbid its further employment.

CHAPTER II.

IRRITABILITY OF THE BLADDER.

This term is usually employed to denote any affection of the bladder attended with frequent desire to void the urine. I wish, however, to express by it, a frequent, and often irresistible, desire to micturate, not arising from inflammation, nor from any organic affection of the bladder or prostate gland, and sometimes, but not always, attended with pain. The frequent desire to micturate is the chief symptom of this complaint.

Thus, a person previously enjoying good health, feels, suddenly, a desire to void urine every half-hour, or oftener; and the desire is so strong, that, unless he yield to it at once, the urine passes in spite of all attempts to prevent it; or, if he succeed in checking the desire, uneasiness, pain, or even paralysis of the bladder is apt to occur. In this disease the act of micturating is sometimes, but not always, attended with pain in the glans, or under the frænum, and with violent efforts or straining.

The urine, except in hysterical subjects, is voided in small quantities; and although such quantities are frequently passed, their aggregate does not much exceed that of a person in health.

Hysterical persons sometimes suffer from irritable bladder, and great pain, may also be experienced in passing urine. In these patients, the quantity of urine is often considerable, and possesses the aqueous character, or contains less than the usual proportion of solid matter, the nature or relative quantity of its constituents remaining the same. This peculiarity in the quantity and quality of the urine is capable of explanation perhaps, to a certain degree, from the fact that the viscera apt to be deranged in hysteria, all derive nerves from the same source, namely, the abdominal ganglionic system.

Opportunities for examining, after death, the bladders of persons who laboured under idiopathic irritation of this organ, are exceedingly rare. I examined the body of a gentleman, of very nervous temperament, who having long been a sufferer from this affection, was carried off by disease of the lungs, but I could not detect the least alteration in the appearance or structure of the bladder, or of any of the urinary organs.

After long-continued irritation, the bladder diminishes in size; and, instead of containing a pint or more, is incapable of holding above two or three ounces. Notwithstanding this contracted state, if there be no stricture or disease of the prostate, the parietes of the bladder are often thinner than natural. It would, therefore, seem that long-continued irritation produces actual absorption of part of the substance of the bladder.

Where a case of irritability of the bladder comes under the notice of the surgeon, the first and great object of inquiry is, the cause on which the irritation depends. It may arise from pressure of the womb in pregnancy, hardened fæces, hemorrhoids, or foreign bodies in the bladder. In almost all cases of stricture, the bladder is liable to irritation ; but, in all these cases, if there be no alteration in the structure of the organ, the irritation subsides when the cause is removed. After the operation for stone also, the bladder often remains irritable.

The slightest derangement in the digestive organs, by disturbing the functions of the kidney, may cause irritability of the bladder. Adults and children more particularly, are, in the summer season, from eating fruit, very liable to this affection. In these cases, the urine contains an excess either of uric acid or of urate of ammonia ; and we are further to recollect that the malic, citric, and other vegetable acids, are conveyed to, and excreted by, the urinary organs, unchanged by any process of digestion or sanguification.

The common cause of irritable bladder is a morbid condition of the urine. It rarely happens that this viscus, when free from organic disease or changes of structure dependent upon stricture of the urethra, is unable to retain healthy constituted urine, which acts as the natural stimulus to its mucous membrane. This opinion was entertained by Dr. Prout, who remarked, (*On Stomach and Renal Diseases*, p. 366,) "Cases of irritable bladder depending on functional derangement of the kidneys usually result from the unnatural properties of the urine. All deviation from the normal condition of the urine, whether in deficiency, in excess, or in kind, are recognized by the containing organs, and may prove a source of irritation in the kidneys and bladder. Hence, whenever the urine is very dilute or very concentrated, or is preternaturally acid or alkaline, or contains any unnatural ingredient, the urinary organs in general, and the bladder in particular, though perfectly healthy, are liable to become excited and irritable, and the individual has no peace till the unnatural secretion is discharged. In such cases the fault lies, not in the bladder, but remotely in the kidneys and assimilating organs."

Sometimes irritation is produced by taking alkaline remedies for too long a time ; and, in this case, the urine becomes alkaline. I was consulted for irritability of the bladder by a gentleman whose urine was alkaline, but whose appearance and state of constitution did not lead me to expect this state of the secretion. On inquiry, I found that he had been in the constant habit of taking the sesquicarbonate of soda in large doses. I ordered him to discontinue its use, and he soon recovered. The altered state of the urine being often the immediate cause of irritability, this condition of that secretion should especially engage our attention.

Many gouty and rheumatic persons are subject to this complaint. It often occurs, that a patient with irritable bladder applies to his medical man, who, on inquiry, finds him occasionally subject to pains in the limbs and loins, to some scaly eruption on the skin, and sickness of a morning ; that the urine is usually passed in small quantities, is very acid, and contains a large quantity of the urate of ammonia.

The following case illustrates this common form of the disease :—A gentleman, forty-two years of age, and subject to rheumatism, applied to me on account of a very frequent desire to pass urine, from the annoyance of which he had for several years suffered. He was affected with a scaly eruption, of a leprous nature, on several parts of the body, particularly about the elbows and knees ; and he often felt severe pains in the hips and loins. The urine was very acid and scanty. I ordered him a mixture of diosma, henbane, carbonate of potash, and sarsaparilla. I gave also blue pill and rhubarb at bed-time. On the 3rd of March, the irritability of the bladder was much lessened, and the eruption improved. I then gave the decoction of the pareira brava during the day, with a grain of the acetous extract of colchicum at bed-time. His complaint was much relived, but not cured.

Great irritability of the bladder and urethra, with increased secretion from the mucous membrane of these parts, is frequent with some persons shortly before a fit of gout. The disease assumes the character of gonorrhœa, and is attended by pain and scalding in making water, the calls to perform which act are frequent and urgent. These symptoms of irritability of the bladder are more likely to occur when the urethra is affected with stricture.

" During the most frequent symptoms of the paroxysm," says Sir C. Scudamore, (*On Gout and Rheumatism*, p. 18,) " the urine is usually passed with considerable irritation, both as to frequency and sense of heat. The pink or lateritious sediment appears, more or less, in every portion of the urine, during the inflammatory symptoms. When these have entirely subsided, and the state of the liver (on the condition of which the symptom in question principally depends) is still remaining unhealthy, the sediment of the urine often assumes a whitish colour, and is compared by the patient to the appearance of magnesia. This and the pink sediment frequently alternate, one or the other appearing as inflammatory or nervous action most prevails. Sometimes, however, it occurs that a patient who has for years been labouring under irritability of the bladder will have this symptom relieved or suspended during a paroxysm of the gout." The lateritious sediment is composed of urate of ammonia tinged with the yellow colouring matter of the urine, and occasionally by the purpurate of ammonia, the latter indicating chronic disease of some of the abdominal viscera, and especially the liver. The white sediment is the urate of soda, which, in certain gouty constitutions, is apt to be deposited in an amorphous form, rendering the urine of a milky colour. "I have seen it," says Dr. Prout (*On Stomach and Renal Diseases*, p. 196), "copiously secreted of the consistence of mortar, especially during the night, and in this case it is apt to collect into masses and to block up the urethra."

Irritability of the bladder is sometimes the result of a mere nervous state of the organ, of the same spasmodic nature as that which in other individuals, and other parts, occasions a constant winking of the eyes, or twitches of the muscles. It may be idiopathic, or may be excited by disease in some neighbouring organ, as the uterus or rectum. In the former case, the frequent voiding of the urine, being once begun, is kept up by habit; the bladder becomes less capacious; and it is not until after some time, nor without some effort on the part of the patient, that it is restored to its natural condition and capacity. Various mental affections, as grief and anxiety, cause this complaint; and it is often connected with a peculiar state of the nervous system.

Scybala in the intestines may give rise to this complaint. I have already assigned a reason why sympathy should exist between the bladder and other pelvic viscera, by which the diseases of one may be mistaken for those of the other; but sympathy is not confined to these, for certain parts of the primæ viæ, sometimes the stomach, sometimes the ileum, often the colon, and still oftener the rectum, being the seat of irritation, sensations are produced in the bladder, the perineum, or urethra, which fill the mind of the sufferer with serious apprehensions as to the result.

I have known irritation supervene on paralysis of the bladder. A gentleman, during an attack of typhus fever, was seized with inability to pass urine. It was drawn off twice a day. As he gained strength the power of micturating returned, and the desire to pass it then became so frequent as to compel him to do so every half-hour. He consulted me for this symptom. There was no disease in the urinary organs, and, with the exception of occasional rheumatic attacks, his general health was good. The urine was very acid and scanty. I ordered him a grain of the acetous extract of colchicum at night, and ten grains of bicarbonate of potash, seven of sesquicarbonate of soda, and four of nitrate of potash, twice or three times a day, soon after meals. By these means the urine became more abundant and less acid ; but frequent micturition continued. I tried the infusion of diosma, the decoction of the pareira brava, and various preparations of steel, for the relief of this annoying symptom, but without success.

I have known in children, a contracted state of the prepuce cause irritability of the bladder. A striking case of this kind occurred to me some time ago :— The boy, seven years of age, had for the previous eight months, complained of a frequent desire to make water, attended with difficulty in passing it, and pains round the lower part of the abdomen. On examining the prepuce, I found it so contracted as scarcely to admit the point of a probe. I immediately removed the end of the prepuce by circumcision. From that time the symptoms subsided, and the child recovered. Again, a boy, eleven years of age, had suffered during two or three years from pain in making water and incontinence during the night. He became my patient. I found the prepuce as contracted as in the previous case. The boy was treated by simple division, and all symptoms vanished. In these cases, the division or removal of the extremity of the prepuce suffices for the cure of the complaint.

Irritability of the bladder is not uncommon in children, especially at the period of dentition. We may infer in most of these cases that there exists something unnatural in the composition of the urine, although chemical analysis may not at all times succeed in detecting it. Considerable perseverance may be required on the part of the patient to overcome this troublesome complaint, especially if an involuntary discharge of urine occurs, as it commonly does, during sleep.

A morbid desire to empty the bladder is a frequent symptom concomitant with the development of malignant disease in the prostate gland and adjacent parts. This subject, however, will not be considered in the present chapter further than to remark that in investigating a case, the possibility of the existence of such disease should be present in the mind of the surgeon.

When the amount of urine secreted by the kidneys during the twenty-four hours is greatly increased, as in diabetes, for example, a patient, overlooking the real nature of the case, may imagine, from the frequent calls to make water, that he is suffering from irritable bladder. Hence, accurate inquiries should always be made as to the amount of urine voided upon each occasion, and the aggregate amount passed in the twenty-four hours. The analysis of the urine is indispensable.

Irritability of the bladder may, in many cases, be mistaken for an inflammatory affection of the organ. The distinction however, is easy, and of great practical importance. If the disease has recently occurred, it may be distinguished from acute inflammation of the bladder, by the absence of pain and of those severe constitutional symptoms which characterize the latter disease. If it has been of very long standing, it may be distinguished from chronic inflammation of the bladder, by the general health suffering but little; whereas, in chronic inflammation, the constitutional powers sooner or later give way. In the following case the complaint was of very long duration, and the health was but little affected.

A gentleman, sixty-five years of age, of good constitution and regular habits, consulted me on account of a very frequent desire to pass urine, unaccompanied with stricture, disease of the prostate, or any other affection that I could detect. Thirty years previously he had consulted Mr. Jesse Foot for the same complaint; and the lotura vesicæ was then tried without affording relief. This symptom has continued ever since; being aggravated in cold weather, and on any excess in living or derangement in the health. In other respects, he is quite well.

Those cases, in which the cause of irritability, supposed to be confined to the bladder, is, in truth, to be referred to the kidneys, though often attended with great obscurity, may generally be elucidated by attention to the symptoms, and accurate and repeated analyses of the urine.

Morgagni (*On the Seats and Causes of Disease. Letter XLII.*) relates a case in which the bladder was thus the seat of sympathetic pain; the disease being in the kidneys. The patient, he says, complained of very little pain in the region of the kidney; while he was tormented with pain in the bladder, so excruciating, that five or six physicians who attended him, entertained no doubt of the seat of the disease being in that organ. On dissection, however, no morbid appearance was discovered in the bladder; and there were large and ramifying calculi in the kidney.

In certain renal affections in particular habits, says

Dr. Prout, even where the urine is not very unnatural, the pain is confined chiefly to the neck of the bladder; but when the urine is actually diseased, and more especially when it is alkaline, we may be certain that the kidney is functionally, and if the patient be of scrofulous habit, and the case of long standing, very probably organically, affected. And here I would refer to some interesting cases of irritation of the bladder dependent on the disease of the kidney related by Mr. H. J. Johnson. (*Medico-Chirur. Trans.* Vol. xxiv., p. 193.)

In idiopathic irritability of the bladder, which has not been of long continuance, the treatment is usually plain; the state of the general health and the condition of the urine being our guides. In gouty and rheumatic subjects, in whom the urine is generally acid and scanty, and red sand often passed, the alkalies should be administered; and a good form for their exhibition is a combination of potash, soda, and nitre. The carbonate of potash is to be preferred to the carbonate of soda, because, under certain circumstances, soda enters into combination with the uric acid, forming an insoluble salt, as deleterious as that acid itself: whereas the urate of potash is perfectly soluble, and if this combination should take place, it passes off dissolved in the urine. In addition to the alkalies, the acetous extract of colchicum, in doses of one or two grains, should be given at bed-time; and if the digestive powers be weak, as is often the case, some tonic, as infusion of cascarilla, columba, or hop, a short time before meals, will be found serviceable. Great relief will sometimes be obtained from cupping on the perineum, the warm bath, the use of the liquor potassæ and tincture of hyoscyamus, and occasional doses of blue pill and saline aperients. When we can trace the irritable state of the bladder to mischief in the kidney, setons and issues in the lumbar region in addition to other means must be employed.

In these, and indeed in all cases, the strictest attention should be paid to diet. Vegetables and fruit should be avoided, as well as wine, spirits, and all fermented liquors.

In some constitutions, notwithstanding the acid state of the urine, and the deposition of a large quantity of the urate of ammonia, the alkalies disagree, producing restlessness, giddiness, and uneasiness about the region of the stomach. I recently saw a gentleman who had great irritability of the bladder, and whose urine, which was very acid, deposited great quantities of the urate of ammonia, but who could not bear even small doses of alkaline remedies.

If the patient be of a nervous temperament, and the urine alkaline, a different plan of treatment will be necessary. The dilute mineral acids, combined with the decoction of pareira brava, should be administered, and everything having a tendency to lower the system, as attention to business, study, or anxiety, studiously avoided.

In other cases, where the urine is neutral, the extract of the uva ursi, in five grain doses, combined with that of the hop or hyoscyamus, may be taken in single or double doses, three times a day. Opiate suppositories or injections per anum, with some drops of the liquor opii sedat. may be administered, according to the severity of the symptoms. I usually direct seven or eight grains of the soap and opium pill to be administered in this way at bed-time, or the liquor opii sedations in an injection of starch or gruel.

The decoction of uva ursi, and the infusion of wild carrot seeds, will occasionally give great relief. In my experience, however, no medicine has been so generally successful in irritability of the bladder, as the infusion of diosma. I could cite several cases, where it has succeeded after other medicines had failed. A gentleman, æt. twenty-one, applied to me on account of an affection of the bladder. He said that, for the previous eleven or twelve years, he had experienced great difficulty in retaining his water for any length of time, being obliged to void it once or oftener in the hour. The moment the desire to micturate came on, the water, unless the desire was immediately complied with, passed away involuntarily. This irritability of the bladder was always very much aggravated by the use of malt liquors, wine, or spirits, and by exposure to cold. Latterly it had considerably increased. He was very susceptible of cold, complained of pains down the inside of the thighs, but had no pain in the region of the loins on pressure, nor any over the bladder, and his general health had not suffered. The urine was neutral and light-coloured. After trying the various preparations of steel, the decoction of pareira brava and henbane in different forms, without success, I ordered the infusion of diosma, with great benefit.

From time immemorial, the buchu leaves have been held in great esteem by the natives of the Cape of

Good Hope, as a remedy for a number of diseases, particularly irritative or chronic inflammatory affections of the urethra, bladder, prostate gland, and rectum, and also for rheumatism, indigestion, and gravel. These leaves have been very successfully prescribed in the same complaints, both in Holland and in this country. There are several species of this shrub, but that termed "Diosma crenata," is most esteemed for its medicinal virtues. It affords, on distillation, an essential oil, resembling a mixture of oil of rue, juniper, and camphor ; the extractive matter being slightly bitter and mucilaginous. The natives of the Cape, and the Dutch, who have learned from them the use of the plant, are partial to the spirit of buchu, made by distilling the leaves in the dregs of wine, and called buchu brandy. They regard it as a sovereign remedy for all chronic diseases, and even for acute ones, of the stomach and bladder, especially colic spasms in the stomach and intestines.

When a scaly eruption is present and the urine acid, the bicarbonate of potash, tincture of henbane, and the fluid extract of sarsaparilla added to the infusion of diosma is a very useful form ; but the alkali must be omitted if the urine is not acid.

Mr. Jesse Foot, was a great advocate for injecting the bladder in cases of irritation of that organ ; but since his time the plan has never been extensively tried. Mr. Wadd, indeed, mentions two cases in which great relief was experienced from the lotura vesicæ, and expresses his surprise that it is not more resorted to by practitioners. The bladder may be injected with simple tepid water, or with some bland mucilaginous decoction, as that of quince seeds or linseed ;

and the injection may be repeated once or twice a day, the quantity thrown up, and the time of retaining it, being gradually increased. I have tried the injection of the bladder in cases of simple irritability, but am disappointed in the results. It is certainly a valuable remedy in an affection of the bladder hereafter to be noticed; but I do not consider it of use in the complaint now under consideration.

Irritation of the bladder and urethra dependent on gout and rheumatism, yields in general to the administration of colchicum, combined, if necessary, with a narcotic at bed-time. Dover's powder is usually selected, but I prefer the preparations of morphium. The iodide of potassium deserves a trial from its well-known curative influence in rheumatic affections. Guaiacum also has been strongly recommended, but I have no great faith in its efficacy.

In the irritability of the bladder met with in young females at the time when menstruation should take place, or when some irregularity in that function has occurred, the preparations of iron are of great service. The ammoniated or the muriated tincture of iron, given in some light bitter infusion, is serviceable; and if the bowels be costive during the use of the remedy, the compound decoction of aloes should be daily administered. The bowels should be kept well open, for the symptoms of the disease are invariably aggravated when the bowels become costive. If there be much hysteria, the tincture of valerian, combined with the vinum aloes, may be also tried with benefit. The cold shower-bath will likewise be found very serviceable in such cases.

When other remedies have failed, I have known the tincture of cantharides succeed. I was consulted by a woman who, at night, suffered from incontinence of urine. She was healthy looking, temperate in her habits, and twenty-two years of age. She had recently married, and was much distressed from the complaint under which she laboured. There were no pains in the loins, nor any symptoms of disturbed secretion in the kidneys. I ordered her to take five drops of the tincture of cantharides three times a day in a little water, and in a few weeks the complaint entirely ceased.

In children, incontinence of urine usually depends on an excitable state of the bladder, as I have before stated, or an altered condition of urine. In either instance, the bladder cannot contain more than a small quantity of urine, before the call to avoid it is felt, and this is so sudden and irresistible, that it must be obeyed, or the contents are at once expelled. In some cases it occurs during sleep, and the urine often passes off voluntarily under the influence of a dream.

It has been observed that this state hardly amounts to disease, but depends upon an unusual and temporary susceptibility of the nerves of the organ to the stimulus of distension; so that, when this has once reached a certain pitch, the action of the antagonizing muscles is of no avail, and the law established between the sensation resulting from that distension, and the generation of motor power, enforces instant obedience. It is commonly thought that these circumstances are to be overcome by punishment; yet unless the principle upon which punishment operates be strictly kept in view, the unfortunate boy may, as indeed he often is, be subjected to unavailing cruelty. Punishment can only operate by awakening attention to the first approaches of the sensation ; so that the child may anticipate, by an act of will, that degree of distension which enforces the sequence, and which, when it has arisen, no effort of the will, even under the dread of punishment, is adequate to resist.

It is a good plan to prevent the sleep being too long and to awaken the child at stated periods to evacuate the bladder. The affection, however, is often very troublesome, and requires great determination on the part of the little patient, as well as patience and firmness in those about him for its cure.

The result of modern investigation shows that cases of pure idiopathic irritable bladder are not so common as has been heretofore supposed, and that the frequent desire to micturate, indicates an unnatural state of the urine, or the existence of some organic disease, exercising by sympathy an influence upon the bladder. Their relation to stomach complaints has been abundantly shown by Dr. Prout.

Although, therefore, some forms of irritable bladder may appear so trifling as scarcely to deserve remark in this work, it should be remembered that in their investigation and diagnosis in practice, there is required a general acquaintance with the different forms of renal and other urinary diseases, and the power of ascertaining by chemical analysis with considerable accuracy the nature and relative proportions of the ingredients in the urine.

CHAPTER III.

SPASM OF THE BLADDER.

The bladder, like any other muscular organ, is subject to spasm, an affection arising from many causes, and differing from irritability, inasmuch as the attacks occur at intervals between which the patient enjoys perfect ease.

A fit of stone, as it is familiarly called, is an instance of a violent paroxysm of spasm of the bladder; and in various affections of the uterus and rectum the organ is liable to attacks of a similar nature. The patient, who is suddenly attacked, experiences severe pain extending from the region of the bladder, along the urethra to the extremity of the penis. The urine may be expelled involuntarily, but more commonly there is retention with some amount of suppression from the orifice of the ureters being closed by the spasm. There is constant desire to void urine without the ability to do so, and the agony felt during the continuance of these attacks is excessive, and the hard and contracted bladder, pressing upon the rectum, excites a feeling of desire to evacuate the contents of the bowel.

This affection is almost invariably a concomitant of stone in the bladder; and it is a very common attendant on gonorrhœa, especially when injections have been employed either too strong in composition or too early in the treatment: in the latter instance the disease affects the sphincter vesicæ more especially, and usually is attended with more or less of inflammation.

Instances are said to have occurred in which the patient has expired with all the symptoms of suppression of urine, and upon examination after death, it has been found that the ureters, spasmodically closed at their vesical extremity, have been dilated by the accumulated urine; that the pelves of the kidneys have been similarly enlarged, and that the substance of the kidneys has suffered. Indeed after an attack of spasm from which the patient has apparently recovered, it sometimes happens that we have subsequently to treat a new train of symptoms indicating the injury which the tubular and secreting substance of the kidney has received. Spasm of the bladder, says Dr. Prout, may arise from the presence of acid urine, or from an abscess in the kidney, from ulceration or other organic disease of the bladder, prostate, &c., from retention of urine, from gout, from excessive venery, the use of irritating diuretics, as cantharides; from various diseases of the intestinal canal, as worms, and especially ascarides, from hysteria, &c.

Spasm may be confounded with acute inflammation of the bladder. In inflammation, however, the pain is constant, commencing with more of uneasiness than of positive pain, and becoming more intense by degrees; while in spasm, the seizure is as severe as it is sudden. In the former, the pain has the usual character of inflammation—it is lancinating and throbbing; whereas in the latter, it is constrictive, resembling, in fact, labour-pains. In both there usually is retension of urine.

Frequent recurrence of spasm of the bladder sometimes injures its tone so much, as eventually to induce an opposite state of the muscular fibres: in other words, the disease terminates in paralysis of the bladder.

With respect to the treatment of the disease, this necessarily varies with the cause in which it originates. If spasm be conjoined with inflammation, we are called upon to adopt a strict antiphlogistic mode of cure: leeches are to be applied over the pubes, or to the perineum; if the symptoms be violent, and go on increasing in intensity, venesection must be had recourse to, and repeated if demanded by the urgency of the case. These means are to be followed by the warm bath, local fomentations, and opiates, which are to be administered both by the mouth and in the form of enemata.

If there be reason to believe the affection to originate in a gouty diathesis, or to owe its presence to a suppression of a paroxysm of this disease, while we endeavour to allay the symptoms affecting the bladder, we are to strive at the same time to induce the gout to make its appearance; for which purpose we should apply sinapisms to the feet, or even blisters to the calves of the legs. The operation, indeed, of the latter affords, as Soemmering has already observed, a diagnostic peculiarity, from their often proving most beneficial in the removal of a morbid state of the bladder, which otherwise they are so apt to induce. Among the palliatives of the symptoms affecting the bladder, I have found none more efficacious than a combination of colchicum, opium, and camphor, or hyoscyamus. As soon as we have got rid of the arthritic strangury, we are to direct our attention to the systematic treatment of the disease, to avert its recurrence.

In cases where the cause of the disease is attributable to the improper use of the injections in urethritis, the treatment does not differ in principle from that laid down for spasms combined with inflammation. It rarely happens that general bleeding will be required; but as the usual effect of strong injections is to stop the discharge, we are to use every soothing means to procure its return.

If the cause of the spasm proceed from the kidney, our plan of treatment, after removing the pressing symptoms, must be founded on the removal of the original source of the affection; since, as far as the spasm is concerned, we can never expect to prevent its recurrence, but by the cure of the disease from which it proceeds.

The same observations apply when spasm of the bladder arises from the presence of a calculus. Our treatment can only be palliative and of a temporising nature; for nothing but the extraction of the stone can be relied upon for a permanent cure. As an immediate means of relief, no medicine is preferable to opiates, which may be exhibited by the mouth, or in form of enema or suppository.

In all cases the introduction of instruments into the bladder ought to be sedulously avoided, unless where it has become necessary to ascertain whether or no a stone be contained in the bladder.

In cases of spasm of the bladder proceeding from sympathy with some contiguous organ that derives its nerves from the same source, the tinctura ferri sesquichloridi often proves of great service. The sphincter vesicæ is commonly the seat of the spasm, and with it we consequently have retention of urine. The operation, therefore, of the remedy appears to be purely antispasmodic, and its influence frequently is almost immediate. The usual mode of administering it is to give fifteen to thirty minims every quarter of an hour until the spasm yields.

Where there is reason for suspecting that the acrid quality of the urine is a main exciting cause of the spasm, the indication of diluting the urine by drinking freely of some diuretic beverage is obvious ; and when acidity is its predominant character, this must be abated by exhibiting alkalies with the diluent : or if strongly alkalescent, this must be altered by the administration of some mineral acid.

A poultice containing powdered camphor is frequently very serviceable when applied to the perineum. Some recommend a liniment, composed of camphor and opium, to be rubbed on the same part. Emollient glysters containing some of the watery extract of opium often afford instant relief.

A tobacco enema has been recommended by some in cases of strangury in old people ; but it is at all times a dangerous remedy, and, in my opinion, ought never to be employed. Others have given the same medicine by the mouth. It is one of the most powerful of the antispasmodics, it must be granted ; but its efficacy is uncertain, and its hazardous properties unequivocal.

In all obstinate cases we are to watch lest inflammation supervene : in which case we must immediately have recourse to bleeding both general and topical, and rigorously adopt all the other means known to abate and remove inflammatory action.

CHAPTER IV.

PARALYSIS OF THE BLADDER.

THE muscular coat of the bladder may become paralysed from any of those causes which induce loss of muscular force in other parts of the body. There may be either simple diminution or complete loss of expulsive power ; and the paralysis may be temporary or permanent. A patient suffering from any disease —phthisis, for instance—which produces general debility and wasting, is frequently subject, at irregular intervals, to more or less inconvenience and difficulty in expelling urine. This arises not merely from loss of power in the abdominal muscles, whose contraction aids the first expulsive effort of the detrusor urinæ, but from weakness in the bladder itself, the stream flowing slowly and the organ often being imperfectly emptied.

A person, being in the presence of females or in some inconvenient situation, neglects to empty the bladder, and upon attempting afterwards to relieve himself he finds that he has lost the power. The urine is then either drawn off by the catheter, or in the course of some hours it flows by the patient's own efforts. The organ then resumes its usual functions. Complete paralysis of the bladder, associated with a similar condition of other muscular structures, dependent upon disease or injury of the spinal chord, is, in most instances, permanent, although it may develop itself slowly and gradually.

Unlike the rectum, the bladder retains its contents when paralysed ; and much has been written both in this country and abroad to explain why such opposite results should ensue from the same cause to two organs almost similarly constructed, in juxta-position, and supplied by the same system of nerves. The explanation of the phenomenon lies in some peculiarity in the neck of the bladder not possessed by the rectum ; the sphincter vesicæ, if indeed there be any such muscle, does not lose its power of contraction, to the same extent at least, as the sphincter ani. There are undoubtedly circular muscular fibres around the neck of the bladder, under the longitudinal fibres ; but they are pale and mixed with elastic tissue, by which their action is essentially modified. The same loss of power which allows the escape of fæcal matter through the paralysed sphincter ani, does not affect, to a similar degree the sphincter vesicæ, whose elasticity inherent in the tissue itself and not dependent upon nervous influence, retains closed the vesical orifice when the rest of the organ is paralysed. The neck of the bladder and the prostate gland are fixed in situ by the pelvic fascia, and by the ligaments of the bladder ; in distension of the organ, therefore, this part does not rise from the pelvis. Indeed the trigonum vesicæ immediately behind the prostate, sinks lower, and against the anterior surface of the rectum. In other parts the walls of the bladder yield and mount towards, sometimes even above the umbilicus, and if the distending cause be slowly produced, press the other viscera against the diaphragm. When the bladder is full, it flows over; in other words, the urine dribbles through the urethra, the resistance to its escape at the neck being overcome when the walls of the organ are dilated to their utmost extent. Thus it is that incontinence of urine is often a symptom of retention. In illustration of this important point, Mr. Lawrence states the following case:—"It happened to me, a good while ago, to be sent for, to see a gentleman labouring under an affection of the bladder; and the medical attendant, who had lately seen him, mentioned that the case was one of great irritability of the bladder, which would hold no water at all—the urine passing off as fast as it came into it. He said he had been doing all he could to get the bladder's natural power of retention restored; he had directed the patient to take diluent liquids; in short, he had done all he could to prevent it; but still the water ran off. It appeared to be a singular case. I put my hand under the clothes upon the abdomen; and I felt the fundus of the bladder forced up a good way above the umbilicus. I said that I had brought a catheter with me, and that I might as well introduce it, to see if there was anything in the bladder. I introduced it; and about five pints of urine immediately flowed off. The fact was, the bladder had been, in this way, allowed to distend for about five days before I saw the patient; and the consequence was, that he never afterwards recovered the natural power of emptying that viscus; but he acquired, after a certain time, the art of introducing the catheter, which he still employs: he can introduce it, and let the water off whenever he finds a desire to do so ; but since that time he never has been able to empty the bladder by the natural powers."

I have met with cases in which the sudden abstraction of a large quantity of urine from a bladder which has been long paralysed, has been followed by severe constitutional symptoms,—by rapid collapse, and even by death. One case in particular occurs to me. I was consulted by a gentleman in consequence of a constant desire to micturate, a very small quantity of urine only being passed at a time. After he had made water, and thought he had completely emptied the bladder, I introduced a catheter and drew off a pint and a half of of urine extremely fœtid, turbid, and mixed with thick muco-purulent matter. From this time the catheter was passed three times a day, but in a fortnight afterwards he suddenly became comatose, and in three days he died.

If, by the use of the catheter, the bladder should happily recover its natural power, the patient must be strongly impressed with the importance of never again allowing the urine to accumulate in such quantity, but of immediately passing it as often as he feels the smallest inclination, or, if unable to expel it, of making timely use of the catheter. The patient ought also to be informed of the necessity, on every occasion, of voiding the urine even to the last drop.

Although the complaint is often met with in old persons, it not unfrequently occurs in others who are under thirty-five or forty years of age, and whose constitutions have been impaired by venereal excesses, long courses of mercury, anxiety, fatigue, and excessive attention to business. Before the attack, the patient complains of pain in the head, or some part of the back, weakness in the loins, and inability to walk firmly, flatulence, or a sense of fulness in the epigastric region, and he feels and looks as if threatened with some impending mischief. If these symptoms be not relieved, paralysis of the lower extremities often follows ; and the bladder partakes of the affection.

I have known, however, paralysis of the bladder to occur where the previous habits were regular, and the state of health was in other respects good. There is a large class of cases of paralysis, in which the symptoms closely resemble those of irritation, and are often mistaken for it. A patient complains that during the day he is troubled with constant desire to make water ; every half-hour, and indeed sometimes yet more frequently, he is constrained to relieve the bladder ; his business and his pleasures are both interfered with ; and he is afraid to trust himself for any length of time from home. During the night his urine passes involuntarily, and his rest is broken from the dread of finding his bed wet. The offensive odour proceeding from one the subject of this complaint, renders him unfit for society, as even artificial means cannot completely remedy the evil.

In such a case the bladder has become partially paralysed. It permits of considerable dilation, and contains, under all circumstances, several ounces of urine, and it is only when the accumulation passes beyond the detrusor's point of sufferance, that a feeble contraction produces partial relief. The treatment is clear. The patient should be told to make water in the presence of the surgeon, and immediately afterwards a catheter should be introduced, when, to the patient's surprise, several ounces of urine will come away. This condition is sometimes connected with enlargement of the prostate gland, and is generally described in treating of these affections; but I have very frequently met with it even in persons of middle age, in whom there was no perceptible change of structure in the parts surrounding the neck of the bladder or the urethra itself.

I was recently consulted by a patient for supposed irritation of the bladder, the desire to make water coming on every half-hour. I desired the patient to make water before me, and to empty his bladder; I then passed into the bladder, without the slightest difficulty, a full-sized catheter, and, to the patient's intense astonishment, drew off more than two pints of water. The bladder has not yet recovered its power of contracting, and the patient still requires the frequent use of the catheter; but he can pass it for himself, and is thus relieved of a quantity of turbid and offensive urine, which, in course of time, would have produced changes in the coats of the bladder, and increased the evil. So long as a quantity of urine remains in the bladder there is no chance of its regaining its contractile power; a mistake of diagnosis, therefore, may be attended with very serious consequences.

It was noticed by Hunter, that when the bladder has been over-distended, the mucous membrane becomes mottled with spots of extravasated blood, and that the urine itself is often dark-coloured from the same cause. When there is no organic change in the prostate gland, no calculus, nor any disease of the spinal chord, the kidneys being healthy, the urine does not manifest at first any deviation from the condition of health. If, however, the bladder be allowed to remain distended, unnoticed by the surgeon, the urine, unable to find a free escape, is thrown back along the ureters against the kidneys, excites in the latter organs a kind of inflammatory disturbance of a sub-acute character, by which the cortical or secreting substance becomes granulated and adherent to the investigating fibrous capsule, while the organ itself is partially absorbed. The elements of the blood mix with the urine, and hence we find albumen upon chemical analysis, and blood-discs upon microscopic investigation, at first in inconsiderable, and afterwards in very large quantity.

Paralysis of the bladder falls most frequently under the notice of the surgeon as the effect of injuries or diseases of the spine; and these cases are attended with important changes in the whole urinary system, as well as in the condition of the urine itself. The changes here referred to do not appear to be connected with the particular locality of the injury; they occur equally whether the accident be in the lumbar, dorsal, or cervical regions.

In some cases, the urine first secreted, though free from mucus, and of an acid quality, has an offensive and disgusting odour. In other cases, the urine is highly acid, has an opaque yellow appearance, and deposits a yellow amorphous sediment. After slight accidents, such as a strain in the loins, this state of the secretion usually disappears under proper treatment in the course of a few days. But the most common change produced in the urine by injury of the spinal chord, is the following: it is voided turbid, and of ammoniacal odour; when allowed to remain at rest and to cool, it deposits much adhesive mucus; and, when tested with reddened litmus or turmeric paper, it is found to be highly alkaline; after some time, a quantity of phosphate of lime may be detected in the mucus, and it is tinged with blood; at a later period, a considerable quantity of sanguineous coagulum is blended with the mucus and urine.

The urine received into a hollow organ, whose vital power has been lowered by injury inflicted upon the spinal chord, undergoes partial decomposition. The urea becomes converted into carbonate of ammonia, and the urine thus rendered ammoniacal, excites in the bladder inflammation of the mucous membrane, which pours forth in consequence a large quantity of viscid ropy mucus. The phosphatic salt most frequently found mixed with this secretion is the neutral triple phosphate of magnesia and ammonia, the prismatic crystals of which, presenting different degrees of transparency, form under the microscope very beautiful and easily recognised objects.

If the patient live long enough, the inflammation thus excited by the decomposed urine in the paralysed bladder spreads through the whole thickness of the vesical walls, which are rendered thicker than usual and immoveable; they lose all power of contraction, and form connexions with the walls of the abdomen and adjacent viscera. The catheter under these circumstances, fails in completely drawing off the contents of the bladder, a quantity of highly alkaline and fœtid urine remains to add to the local disturbance, and to impregnate any fresh secretion as it enters the organ from the ureters.

An opinion has been entertained that, in these cases, the ammoniacal condition of the urine is owing to imperfect nervous power influencing the kidneys, and that, consequently at its source, there is a change in the secretion of urine. If this opinion be correct, little relief can be afforded, excepting in so far as the paralysis itself may be relieved. If, on the contrary, the evolution of ammonia, and the inflammation of the bladder, be the effect of the retention, the prospect is more cheering.

Dr. John Snow (*Medical Gazette*, Nov. 26, 1846) has observed, that healthy urine will keep fresh out of the body at blood-heat, for as long a time as it ever remains fresh in the bladder; and with respect to the change in the mucus, there is every reason to believe that in these cases it is the consequence, and not the cause of the alkalescence of the urine.

The principal uneasiness appears to arise from the pressure of the urine against the tender parts at the neck of the bladder, and the pain is referred there and to the glans penis: as the distension increases, these symptoms go off, and the patient does not even experience an inclination to void urine. This arises from the bladder having lost its sensibility, so that pressure is no longer felt, although the bladder is now pressing backwards upon the rectum, and forwards against the abdominal muscles. The local symptoms have in a great measure subsided ; others come on, showing the constitution to be much disturbed ; there is a quick pulse, great thirst, general irritation, anxiety of mind, the tongue is covered with a brown fur, and the patient becomes delirious, with intervals of stupor. Under these symptoms the patient dies, and is not uncommonly believed to have been carried off by typhus fever, totally unconnected with the disease of the neck of the bladder.

Lallemand remarks, (*Letter II.* p. 236,) that we must ascribe to diminution of sensibility, the distension of the bladder and the inflammation of its mucous membrane, observed in disease of the brain and its membranes, when such disease is accompanied with stupor, drowsiness, &c. In that case, the patient makes no effort to expel the urine from the bladder, because he does not feel the impression made by it : it consequently accumulates and distends the parietes of that organ as long as they admit of it, until their resistance being greater than that of the neck of the bladder, the urine dribbles away as slowly as it is conveyed by the ureters, that is drop by drop.

This complaint often attacks elderly persons, particularly those who are gouty and rheumatic. It is the result of general diminution of nervous and muscular power ; the bladder being less sensible to the stimulus of the urine, and being incapable of obeying the will with the same facility as before.

Paralysis of the bladder, Soemmering observes, is peculiarly a disease of old age—the excitability of the organic formation, particularly that of the muscular fibres, gradually decreases; the susceptibility of the nerves becomes limited, and the cellular membrane loses its tone. Hence, he says, that an attack of paralysis is often long announced by weakness in the loins, tottering in the step, and bending of the knees in walking, and from this it may almost always be inferred, that a considerable alteration in the functions of the spinal marrow, and of the nerves proceeding from it and from the sacrum to the bladder, has taken place.

The bladder is rendered incapable of obeying the will with the same facility as before: no longer so susceptible of the customary excitement of the urine, it yields to the urine, and becomes distended, sometimes to an enormous size. Haller saw a bladder in a great drinker, which was able to contain twenty pounds' weight of water. Frank found the bladder so distended as to give the appearance of dropsy; twelve pounds of urine passed at one time through the catheter, although he did not remove the whole of it.

But in old people difficulty in voiding the urine depends most commonly upon some change of structure in the neck of the bladder or in the prostate gland; or the paralysis may be secondary, and dependent upon over-distension of the organ from the difficulty experienced by the patient in overcoming some mechanical obstruction. Indeed simple paralysis of the bladder is a rarer disease of old age than has hitherto been supposed. Morbid anatomy gives us no proof of atrophy or wasting of the detrusor urinæ any more than of the muscular fibre of the stomach or of the heart, while there are abundant specimens to show

how common are enlargements of the prostate, tumours or other similar affections which, by impeding the flow of urine, might make the patient believe that the organ was paralysed. Mercier remarks, (*Recherches sur les Valvules du Col de la Vessie,*) "that almost all who have written on the maladies of the urinary passages say that the contractile power of the bladder can be weakened, or indeed destroyed, by old age, venereal excesses, masturbation, the habit of passing water at too long intervals, etc." He mentions numerous facts to show how frequently some mechanical obstruction is the real cause of the difficulty, and adds with much truth : "I do not deny that old age weakens the muscular fibres of this organ ; but it weakens at the same time those that close its orifice, and are concerned in maintaining the equilibrium." In the examination of the bladder of an old person who has long been subject to difficulty in voiding the urine, we may, it is true, find the walls of the organ thin, but I have hitherto failed, after most careful examination, to detect in the muscular structure that degeneration by which the fibres become changed in appearance, paler than natural, or altogether disappear. If paralysis of the bladder be so common a disease of old age, as has been stated, why is it that atrophy of the walls of the organ is so rare ? The infrequency of its occurrence is noticed by Rokitansky, than whom no one has had a wider field of experience. "Atrophy of the vesical parietes," says he, "occurs rarely. The mucous membrane may be reduced to a very delicate shining membrane, resembling the arachnoid, and the muscular coat disappears with the exception of a few almost imperceptible pale traces; the contractile power of the bladder ceases; its parietes are in a state of permanent relaxation, soft, thin, transparent, pale, anæmic, and friable." This writer twice observed atrophy of the vesical parietes of this description as a substantive disease.

I am not prepared to acquiesce with Soemmering when he says, after describing the weakness of the loins, the tottering steps and bending knees of the old, that these symptoms announce an approaching attack of paralysis of the bladder; and that from them it may always be inferred that a considerable alteration in the functions of the spinal marrow, and of the nerves proceeding from it, and from the sacrum to the bladder, has taken place. The tottering step and the yielding knees are associated with those changes in the muscular, as well as in the nervous system, to which in old age the frame is subject; but the difficulty in expelling the urine which comes on at a later period is by no means commonly due to paralysis,—it is the result of some mechanical impediment offered by the structures about the neck of the bladder which have become enlarged and otherwise altered. Hence it is more common in these cases to find the muscular coat of the bladder positively hypertrophied, it having been called upon to overcome an unnatural degree of resistance. Soemmering relates a case of paralysis of the bladder in which the muscular fibres were found thick, hard, and very red. Such a want of harmony between the theory of the disease during life, and the morbid appearances after death, would be wholly unintelligible, did we not know how frequently similar mistakes have happened to others, and in what way they admit of explanation. There is, I believe, no instance on record of paralysis of a muscle being co-existent with hypertrophy of its tissue. When unable to contract, the muscular fibres become thin, pale, and flaccid,—not thick, red, and hard,—conditions which always indicate increased development to overcome some abnormal resistance.

Authors have described paralysis of the bladder as a result of venereal excesses and of masturbation. The general debility which may result from such habits will affect this organ as well as other parts of the body ; but, as far as my own professional experience goes, I should say that the usual result would be irritability of the bladder, dependent upon a morbidly sensitive condition of the mucous membrane of the urethra ; for patients commonly complain of a tingling sensation at the glans penis, and of a constant desire to pass water, which is voided in very small quantities. Indeed the smarting sensation at the end of the urethra becomes intolerable when a small quantity of urine is collected in the bladder. The only way in which excesses of the above description could affect the expulsive power of the bladder would be by indirectly favouring the development of some disease, such as tuberculosis ; which, attacking the spinal chord, would excite in it changes similar to those with which we are familiar in the lungs ; namely, destruction of the tissue by softening, or by inflammation of the surrounding parts and of the membranes which connect it with the vertebral canal.

The incontinence of urine observed in children, and also in others of a weakly and scrofulous constitution, cannot be explained upon the supposition of paralysis of the bladder, further than that there is a want of equilibrium between the retaining and the expulsive forces. In most instances there is some morbid condition of the urine which excites undue contractions of the bladder: they therefore come under the head of irritable bladder. The following is an example:—A child, six or seven years old, with a large head, pale countenance, bad teeth, prominent sternum, large abdomen, and emaciated extremities, who, from its earliest infancy, had suffered from incontinence. All kinds of remedies had been tried without success. In this case, as in many others, there was great irritability of the bladder during the day, and, unless the desire to pass urine was attended to, it flowed off involuntarily. The urine was very acid.

In some persons, particularly in stout females, the urine will flow involuntarily on lifting a weight, or coughing, or any violent exercise. In such cases, there is no pain, no blood in the urine, no desire to make water often, but merely an involuntary flow on exertion—the action of the diaphragm and abdominal muscles overcoming that of the sphincter of the bladder. In females, incontinence often occurs after distention of the urethra for the extraction of calculi or foreign bodies, and occasionally after difficult labours. Dr. Cory (*Med. Gazette*, March 16, 1839,) relates a rather interesting case of the latter, which speedily yielded to the one-sixteenth part of a grain of strychnia, given three times a day. In these cases, it is probable that the sphincter vesicæ has been injured, and they might properly be described as injuries to the neck of the bladder, the mechanism of which is no longer able to close the orifice. In the female urethra, division of the elastic structures forming its walls, and of the loop of muscular fibres immediately round the neck of the bladder in the course of a surgical operation, is often followed by incontinence of urine; but these again are not cases of paralysis.

We may perhaps speak of a paralysed condition of the neck of the bladder in women who have had very large families—ten or twelve children for example.

In these cases more especially if the child is large, or the pelvis small, when the labour has been severe, the bladder is apt to get so infirm about the neck, that it loses much of its contractile power, and, perhaps, from the moment of delivery, the woman is incapable of retaining the water: or if, any time, she chance to cough, laugh, rise suddenly, or in any other manner contract smartly the abdominal muscles, the water comes gushing away. For years this disease may continue in greater or less severity, but it frequently cures itself, in good measure, and the first few weeks after delivery, say at the end of the fortnight, the patient is better; at the end of the month the retentive powers are still more increased; and in the course of a few more weeks, she becomes able to hold the water very well, though still liable to gushes, when sudden efforts are made. Hence, where inconvenience is the result of an enfeebled cervix vesicæ, time must be looked upon as one of the principal remedial means; in some cases, advantage may be obtained from plunging the hips into cold water two or three times daily. The improvement of the general health, is by no means to be neglected, for the more you improve the general health, the more you will increase those healing powers of the parts on which all cures are more immediately dependent. (*See Dr. James Blundell's Lectures. Lancet,* 1828, p. 73.)

In the case of a lady on whom I operated for hæmorrhoids, the bladder became paralysed, and she required the use of the catheter for some days before it recovered its usual power. In fact, paralysis of the bladder after an operation for piles is not an unfrequent occurrence. Paralysis of the bladder has occasionally occurred from the use of opiate suppositories, or injections ; so that it has been necessary to draw the water off, and much alarm has been occasioned by it ; and here I may allude to a few of the causes which deprive the bladder of the power of expelling the urine, although it cannot, under such circumstances, be said to be in a state of paralysis. The rectum may be distended by flatus, blood, morbid growths, or a foreign body ; and, in these states, the neck of the bladder and the urethra may be compressed.

I have seen a case of diseased hip-joint, in which matter made its escape from the affected joint into the pelvis, so as to press on the neck of the bladder, and caused paralysis of that organ. On examination, after death, I discovered, that the matter had escaped through the acetabulum to the posterior part of the bladder, and had made a lodgment close to its neck.

Children, while labouring under hooping-cough, and at the time of dentition, are liable to retention of urine. Joseph Wm. Brett, æt. two years and a half, whilst labouring under hooping-cough, was seized with inability to pass urine. Two days before, the mother had, on three occasions, observed some blood in the child's urine, and some red sand deposited in the urinal. A small catheter was introduced, and a pint of urine drawn off. After twenty-four hours, this operation was again repeated, and the functions of the bladder gradually returned.

There are two periods in pregnancy (*Traité des Maladies des voies Urinaires, par Desault*, p, 160) when women are especially exposed to retention of urine, about the fourth month, and at the time of confinement. It must be recollected, that, in the first month, the womb continues, as before conception, in the depth of the pelvis ; that it does not ascend above the cavity until the fifth month, and sometimes even later ; that till that time, its size and weight having progressively increased, it even descends towards the vagina, and, in the manner of a wedge, presses posteriorly the rectum, and anteriorly the neck of the bladder, and the urethra against the symphysis of the pubes, to such a degree, as to stop the opening of that canal.

The displacements of viscera, which most frequently give rise to retention of urine, are retroversion of the womb, and prolapsus of that organ, or of the vagina or rectum. If we examine the connexion of the bladder both with the womb and vagina in the female, and with the rectum in the male, it is evident that these parts cannot be displaced without drawing with them the bladder ; and that, in such displacement, whatever may be its contractile force, it cannot entirely expel the urine it may contain.

In the prolapsus and retroversion of the womb, and prolapsus of the vagina and rectum, the posterior part of the bladder, instead of being carried upwards and forwards, must be drawn downward and backward, and the curve of the urethra must be entirely changed. Instead of presenting a concavity beneath the pubes, as in retroversion, the bladder presents there a convexity, a derangement which must not be lost sight of in the introduction of the catheter.

A case is recorded by Mr. Coley, (*Lancet*, 1833, p. 395,) of retention of urine caused by imperforation of the hymen. A young lady, aged sixteen, had been ill three days and nights, with retention of urine; and her medical attendant had been under the necessity of relieving her by the introduction of the catheter twice daily, during that period. The cause of the ischury was found to consist of an imperforate hymen, which, by totally preventing the discharge of the menstrual fluid, had produced a mechanical obstruction in the urethra. The external orifice of the meatus urinarius was situated in a cul-de-sac, and the hymen was tense and slightly protruded. The patient being laid on her back, a double-edged scalpel was passed through the hymen, which was very thick and tough, beginning at the upper part just below the meatus. Nearly four pints of tar-like fluid gushed out; after which the incision was continued down to the perineum. An aperture was thus made capable of admitting two fingers, into which a plug of lint was introduced; at the end of two months she was cured. In performing the operation of dividing the morbid vaginal membrane, great circumspection is requisite, as death has been the consequence in several instances. De Haen, in the sixth part of his Ratio Medendi, mentions a misfortune of this kind, occasioned by the operator having carried his incision, by mistake, into the bladder ; and Denman lost a patient with peritonitis produced by the operation. Parsons (*On the Bladder*, p. 8.) mentions the case of a young woman, of seventeen, with imperforate hymen, who had retention of urine from the lodgment of the menstrual fluid in the vagina. When allowed to proceed without relief, the disease has terminated in death. An instance of this kind is recorded by Dr. Schmidt, (*Ephemer. Ann.* III. 198,) in which the stagnant urine, accumulated in the vagina, eroded the passage and made an opening into the rectum, which proved fatal ; the patient being only eight years old.

The morbid appearances presented after death, are dilatation of the bladder, attenuation of its coats, and a pale white appearance of the mucous membrane ; these, at least, are the appearances found when the kidneys and the mucous membrane of the bladder have not been seriously involved in mischief, as after injuries of the spine. In the latter case, there is great vascularity of the mucous membrane lining the bladder, ureters, and the pelvis, and infundibula of the kidneys ; the mucous surface of the bladder is thickened, of a slate colour, and presents, here and there, dark red spots ; and sometimes it is covered with phosphate of lime, deposited from the mucus, or a white powder is found in the mucus itself, and the bladder contains some fœtid urine.

A few words must here be added upon hysterical affections of the bladder. Although diuresis is the most common complaint, patients not unfrequently declare they have lost the power of voiding the urine, and that none has passed for three or four days.

That there must oftentimes be something beyond the mere waywardness of the fancy is evident from the fact that patients, the subjects of hysteria, have been known to submit without complaint to severe treatment, and even to mutilation, and the loss of a limb. We may have to deal with a case in which we must be prepared against every shade of duplicity and cunning, in which the love of attention, and the desire of exciting commiseration will supersede every other passion, and all the remaining powers of the mind will be turned to learning every symptom, and carefully treasuring up every hint, which, brought out at some future time, may serve to perplex the practitioner and revive declining interest. "To become an object of attention, an interesting object," says Dr. Prout, "is an innate and characteristic feeling of the female mind; and if, in early life, this feeling, in its natural and legitimate form, has been thwarted or disappointed, it is almost sure to deviate into some other channel; and the ruling passion is displayed in attempting to excite pity and commiseration, where she cannot excite erotic sentiments."

The treatment of such a case is obvious. The catheter must not be introduced too early. Indeed, these cases, if left to themselves, usually recover; but, if we once begin to pass the catheter, its use will be for a long time required, and the complaint will be protracted. I distinctly recollect a case of this kind, in which the catheter was introduced once or twice a day, for some time, until at last an opinion was excited that the malady was either feigned or nervous, and that it would be desirable not to introduce the instrument. After this the young woman escaped from my notice; but I learnt that the affection of the bladder soon subsided. As a general rule in these cases, the catheter ought not to be introduced. Care, however, must be taken lest the bladder become truly paralysed, when an effort of the will can no longer be exercised. Morbid changes may then ensue, as in other instances of similar disease.

In the treatment of paralysis of the bladder the first and immediate step required, is to draw off the accumulated urine by means of a catheter; and the operation should be repeated at least three or four times in the twenty-four hours (at intervals sufficiently short to prevent over distension), until the bladder has recovered its contractile power. In some cases, however, less disturbance will arise from allowing the catheter to remain in the bladder than is produced by the repeated introduction of the instrument.

As full a sized catheter as the urethra will admit had better be used; and, if blood is present, it must not only be full-sized, but longer by four or five inches than those usually employed: in old people a large instrument is also necessary, as it develops the calibre of the urethra, the parietes of which, at this time of life, are soft and flaccid: in retention of urine in old people, the bladder frequently ascends above the pubes, and elongates the urethra, which, consequently demands a catheter somewhat longer than those in ordinary use.

The curvature of the catheter must be proportioned to that of the urethra, or, at least, in relation to the period of life; the curve increases from infancy to old age, being greater in the adult than in the infant; while the urethra is most curved in those who are far advanced in life, which is caused by the increase in depth of the symphysis pubis. In ordinary cases of retention, I prefer a full-sized silver catheter, mounted on a rough ebony handle, or a gum-elastic catheter, made of such materials as will enable it to retain its shape. The catheter being well oiled and slightly warmed, the patient stands with his back against the wall or a table, or he may lie in the horizontal position, which is sometimes preferable to the former, with the legs and thighs flexed and slightly separated. The surgeon is to stand on the left side of the patient, and introduce the instrument, with its concavity towards the abdomen and pubes; it is then propelled gently onwards, through the urethra, till the point has arrived beneath the symphysis of the pubes. The surgeon then depresses the handle of the catheter between the thighs of the patient, and imparts to it a slight degree of pressure, or impulsion, to make it enter the bladder, otherwise the beak, in place of passing under the symphysis pubis, will strike against the sub-pubic ligament. This pressure should be very slight; if possible the weight of the instrument, which can be regulated by not holding it too firmly, ought to be sufficient for this purpose.

When it is necessary to pass the female catheter, it is of consequence to be able to do it readily, which is by no means difficult. The woman ought to be placed on her back, with her thighs separated, and the knees drawn a little up. A basin is next to be placed between the thighs, or a bladder may be firmly tied to the extremity of the catheter to receive the urine. The instrument is then to be conveyed under the thigh, and the labia and nymphæ being separated with the finger, it is to be run gently under the clitoris, down the fossa leading to the orifice of the urethra, which is easily distinguished, as an irregular depression just above the entrance to the vagina, and higher or lower from its orifice, according as the vagina is in its natural state or retracted. The point of the instrument is to be moved lightly down the fossa after the finger, and it will readily slip into the urethra. It is finally to be carried on in the direction of the axis of the outlet of the pelvis, and the urine drawn off. The catheter may also be readily introduced by placing the point of the finger just on the orifice of the vagina, and the instrument being then glided along the finger, it either at once, or by the slightest motion upward and downward, slips into the urethra. This operation ought always to be performed in bed; and the patient is never to be exposed. In cases of fractures, bruises, &c., where the woman cannot turn from her side to her back, the catheter may be introduced from behind without moving her.

When the bladder is turned over the pubes, as happens in cases of great deformity of the pelvis, it is sometimes requisite to use a flexible catheter, or a male catheter, with its concavity directed forward.

If the passage of a catheter is required in cases of prolapsus and retroversio uteri, the operation is conducted in a different manner from what has been just described; as in these affections the fundus of the bladder is drawn downwards and backwards, there is a corresponding change in the curve of the urethra, the concavity of which is directed towards the rectum; from such a change of position, it is evident that the convexity of the catheter should be directed to the pubes; the operator will find it more advisable, in such cases, to use the gum-elastic catheter than the silver one. A contrary effect is produced on the urethra during parturition. If the process is tedious so as to require the urine to be drawn off, the operator will find the urethra increased in length, and rendered more curved, in the natural course, as the bladder is forced above the pubes by the fœtus and uterus, and the canal thus elongated.*

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* A very ingenious improvement in the female catheter has been made by Dr. Montgomery, Professor of Midwifery to the School of Physic in Ireland: instead of closing it with a plug, he has substituted a stopcock, and has also adapted to the bell of the catheter a moveable silver cap, to which a fine bladder is attached; the instrument, thus armed, is introduced into the female bladder, the cock is then turned, and the urine flows from one bladder into the other; after being filled it is removed from the catheter and emptied; the catheter remaining *in situ*, and as the cock is closed no urine flows, till the cap and bladder are again applied, which is then ready to receive it. This most comfortable contrivance prevents all exposure of the patient for the application of a urinal, no change of posture is necessary, nor is there any admission of cold air to the patient, which is often very dangerous. It also prevents the necessity of frequent introduction of the instrument.—*Edin. Med. Surg. Journal*, vol. xxix., p. 325; also, Hargrave's *Operative Surgery*, p. 413, et passim.

In paralysis of the bladder dependent on disease or injury of the spine, the catheter should be passed with the greatest care, so as, on one hand, to avoid injury to the mucous membrane, and, on the other, completely to empty the bladder. On this subject Sir C. Bell makes some good observations:—"When the case is one of injury of the spinal marrow, and paralysis is the consequence, you must," he observes, "be especially careful in passing the catheter in these cases. You must pass it slowly, gently, with every possible attention and precaution, and avoid anything like that dexterity, which by French authors is called *tour de maître.* It is especially necessary that you should be cautious in these cases, because there is no sensibility of the part, and you may twitch the instrument, and thereby make an abrasion of the membrane, or so injure the urethra as to lay the foundation for a false passage. Now, it will be found that when a false passage is made, or there has been a rupture of the urethra, and the point of the catheter has gone out of the urethra, there is the greatest probability, in introducing it again, that you hit upon the false passage, the edge of the ruptured part being so apt to catch the point of the catheter, and direct it out of the urethra." These are points of the greatest importance, which, perhaps, have not always been sufficiently attended to in practice. Cases are on record in which abscesses in the bladder and ulcerative perforations have been the result of the point of the catheter coming in contact with the bladder. I need scarcely observe, that if, from any circumstance, as impermeable obstruction of the urethra or enlargement of the prostate, the catheter cannot be introduced, the life of the patient must not be endangered by delay: the bladder must be punctured.

In some cases of paralysis of the bladder, in which the urine is alkaline, and loaded with adhesive mucus, the injection of this organ with water, containing a small proportion of nitric acid, will be of great use. I shall speak more particularly of this plan, in the chapter on chronic inflammation of the mucous membrane.

In paralysis of the bladder, the constitutional treatment depends on the cause and the affection with which it is connected. In cases of disease or injury of the spine, of affection of the brain, and of general debility, the treatment required will of course vary. Dr. Baly has employed strychnine internally in paralysis of the bladder, at the Hôpital de la Pitié, and has obtained from its use very decided benefit. Three patients have been cured in less than a month by this remedy, given in doses from one-tenth of a grain to two grains every four-and-twenty hours. M. Petrequin has likewise related several cases of the use and benefit of the same remedy in paralysis of the bladder, ensuing as a consequence of injury to the spine.—(*Gazette Medicale.*)

If the complaint has not arisen from organic mischief, and the patient is not very old, recovery may take place. As the bladder recovers its tone, the patient fancies he could pass a little urine; and, on making the effort, he voids some, either drop by drop, or in a small stream: the catheter should be then less frequently employed, until its use is entirely superseded. In other cases, particularly in elderly persons, the bladder never entirely recovers its tone, and the use of the catheter is required as long as the patient lives.

CHAPTER V.

ACUTE INFLAMMATION OF THE MUCOUS MEMBRANE OF THE BLADDER.

The symptoms of this disease are, frequent desire to micturate, accompanied by shooting throbbing pains in the region of the bladder, extending towards the urethra, and increased by pressure on the part, and by every motion of the body. There is a sense of heat or burning along the urethra, and a dull pain just above the pubes ; the desire to make water is urgent ; and the pain felt in passing a few drops is often compared by patients to the passing of molten lead. The pain subsides after the urine has ceased to flow, but returns as soon as a little again collects in the bladder. The pain is not only felt along the urethra, and above the pubes, but it shoots into the perineum and down the thighs. The urine is generally acid, and varies in appearance. It is sometimes of a lemon colour ; at other times of a deep red ; and on examination in a transparent vessel by the light, numerous shreds of lymph, or mucus, are seen floating in it.

Sometimes in these cases there is a deposit of a large quantity of deep orange red or yellow sediment, consisting of imperfectly developed urate of ammonia, the urine being more or less serous. These and other varieties in the appearance of the urine depend on the state of the kidneys and mucous membrane of the bladder, and on the immediate exciting cause of the attack. It is remarkable that whatever may have been the nature of the preceding symptoms, or the properties of the urine, it almost always becomes acid before death. At first the urine is not albuminous, but it may become so from extension of the disease along the ureters in the progress of this as well as of other inflammatory affections of the bladder. It is discharged in very small quantities, though the average in twenty-four hours may equal the usual quantity. Sometimes there is sickness, and this symptom combined with pain in the loins, indicates extensive mischief in the kidneys. The pulse is quick and small; the tongue white; the patient is thirsty; the countenance anxious; the skin dry, and often affected with some scaly eruption; and there is general uneasiness, augmented by the absence of rest, and by the constant desire to make water.

If the disease be not arrested in the early stage, the usual results of acute inflammation ensue, as are witnessed in other parts of the body. Flakes of lymph are effused upon the mucous surface; a false membrane may be formed in a continuous layer; ulceration may ensue and proceed until the whole mucous membrane be destroyed; or it may be confined to a particular spot, and extending deeply thence form a fistulous communication with the rectum or other neighbouring viscera. Upon the ulcerated surface we generally find calcareous matter deposited in grain-like sand, or in small flakes.

It is often difficult to decide as to the existence of ulceration ; but there is always reason to suspect it when disease of the bladder has been of long continuance, and when the pain is extensive and increasing. The ulcerative process is attended with constant pain and irritation, keeping up the desire to void the urine, which is never suffered to accumulate ; while, at the same time, increased difficulty and pain generally attend the passing of it.

The walls of the organ generally become thickened, and the muscular fibres, denuded of their mucous covering, stand out in strong relief. Cases are recorded in which ulceration has extended so deeply into the substance of the bladder, as to cause perforation of its parietes and extravasation of urine into the abdomen. In these cases, life is soon destroyed by the extension of peritoneal and cellular inflammation. But when the ulcerative process extends to the other tunics of the bladder, it usually happens that it is accompanied by effusion of lymph, from adhesive inflammation exterior to the ulcer, by which process the bladder becomes united to the neighbouring parts, and prevents the escape of the urine. In this manner, a communication is sometimes formed between the fundus of the bladder and the ileum or the sigmoid flexure of the colon, or between the under surface of the bladder and the rectum ; in the former of which cases, the fæces pass into the bladder, and through the urethra ; while in the latter the urine passes into the rectum, and is voided with the fæces.

Mr. Wilson (*Lectures on the Urinary Organs*, p. 317) says, "I have preserved the bladder and ileum of a person, which had adhered fifteen years before the death of the patient. Ulceration to a large extent had taken place in this connected part; and for the whole of the above-mentioned period, the fæces readily passed from the ileum into the bladder. The patient died when sixty-eight years of age. Being a female, the shortness of the urethra had allowed the substances which passed into the bladder a tolerably free escape, and no calculus formed."

Ulceration between the bladder and rectum is not a very rare occurence, I was requested to see a gentleman, æt. sixty-two, in whom the fæces found their way into the bladder, and were passed by the urethra. He complained of frequent desire to make water, which was attended with smarting and scalding at the time of its passing. He had also great distension about the lower part of the abdomen. Micturition was usually followed by severe darting pains at the end of the penis, and by the escape of flatus through the urethra. The urine, which was acid and albuminous, contained much feculent matter, with a good deal of mucus. It was clear, that in this case, there existed a communication between some portion of the intestinal canal and the bladder, through which the fæces passed; and, during their passage, the pain was intense. The bowels were pretty regular; the motions were often solid; and their passage was not attended with pain. The treatment which was adopted, consisted in the use of suppositories and other sedatives, so as to keep the rectum and bladder in as quiet a state as possible. Some time after, when the fistulous opening seemed to be closed, and the general health was much improved, hæmoptysis occurred. During the treatment pursued for the relief of this attack, there were constant feculent discharges from the bladder attended with great exhaustion.

After this attack, the balance of the circulation was never restored; tympanites occurred, which distended the colon to an enormous magnitude; ascites followed the inflation of the colon, serous diarrhœa and anasarca supervened, and in a few months afterwards the patient expired. For some weeks prior to death, the escape of fæces through the bladder had altogether ceased.*

On dissecting back the integuments, and laying them open, the colon presented the appearance of a large tromboon, amazingly distended, and stretching the umbilical region, with its sigmoid flexure, equally large in the left iliac fossa. The space above its line was occupied by an enlarged liver, and that below by the small intestines. The omentum was shrivelled, and drawn across to the right iliac fossa, where it was adherent to the parietes above the internal abdominal ring. The peritoneum was universally opaque and injected. The sigmoid flexure of the colon, the ileum, and the cæcum, with its appendix, were each and all adherent, *en masse*, to the fundus of the bladder, and involved in a general thickening of the surrounding textures. The bladder, with the adherent intestines, was removed, and a particular dissection made of them, as follows:—

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* Vide Guy's Hospital Reports, No. 13, p. 405.

The colon hypertrophied, singularly muscular, and in circumference about the size of a man's arm, was, together with a convolution of the ileum, and the appendix cæci, adherent to the fundus of the bladder. The natural course of its canal was impeded by a contraction or stricture, which commenced inferiorly in the rectum, about a fore-finger's length from the anus (just at the base of the triangle formed by the vesiculæ seminales), and extended upwards for about two inches, barely admitting the entrance of the little finger. A section of the gut in this part resembled scirrhus: and the glands were, with the surrounding tissues, thickened immediately above this stricture; the coats of the bowel were studded with ulcerations and openings, leading into a channel which separated the bladder from the intestine. This channel was, in fact, a fæcal abscess, situated beneath the reflected portion of the peritoneum, between the bladder and bowel. It was degenerate in structure, lined with a dark membrane, and filled with a muco-purulent excretion. It opened anteriorly into the fundus of the bladder; above, into the colon; below, into the rectum; and posteriorly, through the colon into the ileum; so that there was a false passage, by which the natural course of the colon was diverted, and forced between the bladder and strictured part of the intestine down into the rectum below, and at the same place, by means of a fistulous opening into the bladder, in front. The orifice of this fistulous opening within the bladder was curtained by a fungous growth or thickening which overhung it like a valve. Thus, exactly at this point of the fæcal abscess, there was this strange deformation: the colon, the rectum, and the ileum—each, conjointly with the fæcal abscess, possessed one common entrance into the bladder itself. Within the bladder, the rugæ of its mucous membrane was vascular, and its muscular coat was considerably hypertrophied.

In another case which I attended, a communication existed between the fundus of the bladder and the colon, just above a stricture, in the sigmoid flexure. The patient complained of a deep-seated dull pain in the lower part of the abdomen, extending from the pubes to the sacro iliac symphysis on the left side; he said he had been affected with pain in the bowels for nearly twelve months; and he also complained of considerable uneasiness in the urethra, and of a burning sensation towards the extremity of the penis. The urine was high coloured. On pressing the hypogastric region with firmness, he suffered considerable uneasiness; his tongue was dry, a little furred, and of a brownish hue; his pulse was quick, about 110, and rather firm. He was bled to the amount of about eight ounces; a dozen leeches to the perineum, and a blister to the lower part of the abdomen were applied, and a purgative administered. On the following day, the pulse was softer, and the urine high-coloured, with a very considerable deposit of a purulent kind, and of very fœtid smell. Liquor potassæ and extract of hyoscyamus were then given. On the following day, the urine contained a considerable quantity of feculent matter, which led me to conclude that there must be an ulceration of the intestines. Flatus was also passed through the urethra; stools, voided per anum, were always loose, and the patient said he had not passed a solid stool for a very considerable time. On examination per rectum, the finger could not reach any ulceration or stricture ; and it appeared that no urine had ever passed per rectum. The pain and uneasiness increased ; and the treatment was confined to various forms of opium. The strength of the patient gradually decreased, and he died quite worn out by his sufferings. On examining the body a stricture was found in the sigmoid flexure of the colon, and above the stricture there existed slight adhesion with the fundus of the bladder, towards the left side. There was an opening through the stricture, about the size of a goose-quill, through which some fæces passed into the rectum ; but from the narrowness of this passage, it was impossible that any solid fæces could pass. A portion of the intestine for about two inches above the stricture, as well as part of the fundus of the bladder, appeared gangrenous, and in a state approaching to sloughing; the coats of the bladder were thickened ; the bladder itself was not bigger than a large orange ; and from being much thickened, it appeared incapable of further distension.

This case is a good illustration of the effort which the system, at times, makes to evacuate what is extraneous by the most direct passage when there exists an obstacle to its expulsion in the natural way ; and is strictly analogous, pathologically considered, to what we sometimes see occurring when an abscess forms in the liver. There we find adhesion first taking place between the liver and duodenum or colon; and through an ulcerative process that follows, the matter of the abscess is evacuated by the gut.

The more usual course of this disease is, that ulceration gradually extends to the whole of the mucous membrane, and then the muscular structure is shown more clearly than any dissection can exhibit it. In the progress of the ulceration, disease commonly manifests itself in one of the kidneys; and, as far as my observation goes, usually in the left one.* This is indicated by pain in the loins on pressure (for the pain is never very severe), by shiverings, sickness, and the albuminous state of the urine. At this stage, large quantities of pus are voided with the urine, and the latter is tinged with blood.

With the ulcerated mucous coat there is generally combined hypertrophy of the muscular coat, and a contracted state of the organ. The urine, no longer contained in a viscus capable of dilatation, partly escapes involuntarily by the urethra, and is partly thrown back upon the ureters, which become dilated and tortuous. The mucous membrane, extending upwards along the ureters to the pelvis and the infundibula of the kidneys becomes inflamed and rough, and pours forth a quantity of pus. The glandular structure of the kidney undergoes from pressure slow absorption. The capsule adheres with preternatural firmness to the exterior of the gland. Upon making a section of a kidney so diseased, we find that, although apparently of large size, it consists in great part of dilated tubes, and that the true vascular or secreting part is in smaller proportion than usual.

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* M. Rayer, Traité des Maladies des Reins, tome iii. p. 17, cites the following authors who thought that the left kidney is more frequently affected than the right :—

BOERHAAVE, Prælectiones ad Inst. § 352.

CHARLES LEPOIS (Obser. de Morbis a seros. colluvie t. iv, c. 2, obs. c.) says, that of a hundred subjects attacked with calculus nephritis, upwards of eighty suffered in the left kidney.

HOFFMANN (F.) Med. Ration. t. iv. p. 1, sect. 3, cap. 8, § 7, de febre nephritica.

P. FRANK, Medicina Praxeo.

MORGAGNI (de Sed. et Causis Morb. Epist. xi, art. 13).

KIESEWETTER de Lithiasia sinistro quam dextro Reni magis infesta.—Halle, 1776.

EARLE, Med. Chirurg. Transactions, vol. xi. p. 216, 217, and 227

RICHTER, Spéciale Thérapie, t. iv. p. 4833.

HALLER, Elementa Physiologiæ, t. vii. p. 368.

VOIGTEL, Pathol. Anat. B. iii. s. 188, 207.

COITER (Extern. et Intern. Princip., Observationesque variæ, Observ. xxxiii. §. 3), on the contrary, thought the right more frequently affected than the left.

When pus and mucus exist in the urine in small quantities, it is difficult with the unassisted eye to distinguish one from the other. Pus, however, may be distinguished from mucus, when diffused through a fluid, by rendering the latter opaque. Upon standing, the pus subsides to the bottom of the vessel, and the fluid resumes its transparent character. If, in urine, pus as well as mucus be present, the former is found lying on the latter, and presents a much yellower tint; it is also quite opaque, whereas mucus is more or less transparent.

The microscope affords at once the most ready and the most certain mode of detecting the presence of pus in the urine. The pus-globule is spherical; it is granular on the surface; its diameter is $\frac{1}{2500}$ of an inch. If the urine be acid the nucleus of the pus corpuscle may be seen without the aid of reagents. Should, however, the peculiar shaped nucleus not be clearly detected before the addition of acetic acid, a drop of that fluid, by rendering the envelope of the corpuscle transparent, will instantly bring it into view. The characteristic nucleus of the pus globule is ordinarily tripartite, sometimes quadripartite, more rarely only bipartite ; each division of the nucleus is biconcave, and measures about $\frac{1}{8000}$ of an inch in diameter.

The only bodies with which the pus corpuscles, when passed in considerable quantity with the urine, can be confounded, are young epithelium scales. These, however, are readily distinguished by their solitary nucleus ; for although a pus corpuscle may occasionally be found in which only one undivided nucleus is to be seen, yet it will be lost amid the numbers which present their normal tripartite nuclei. As to the mucous corpuscle, its existence is totally unproved ; under that name have been confounded pus corpuscles seen without the use of reagents, the pyroid corpuscles of Lebert—really a variety of compound granular corpuscles—young epithelium scales and the nuclei of epithelium scales.

The use of the microscope has rendered all other tests of comparative trifling value. The two previously in use were the chemical and the optical. If pus be agitated with equal parts of warm water and a saturated solution of carbonate of potash, a viscid transparent compound is formed :—mucus similarly treated becomes thinner. If a drop of pus be placed between two slips of glass and then held up to a candle, a circular corona of color is seen around the flame, a red area surrounded by a circle of green. The power of thus refracting the rays of light is due to the presence in the pus of the globules above described; consequently, if pure mucus be treated in the same manner, it fails to produce the same effect. Sometimes, however, mucus contains a sufficient admixture of heterogeneous particles, to give rise to a reddish area around the flame.

A copious sediment resembling pus in its apparent characters, is sometimes produced by the presence of a large amount of triple phosphate in the urine. The nature of the deposit is shown by the rapidity with which it is dissolved in nitric acid, and by the shape of the crystals when a little of the fluid is placed beneath the microscope.

Urine containing pus may have an acid or an alkaline reaction. In the former case the pus ordinarily owes its origin to pyelitis, in the latter to cystitis. If urine very turbid from the presence of pus be allowed to stand for a while it becomes clear, and throws down at the same time a more or less abundant sediment; the supernatant fluid frequently has a peculiar greenish yellow tint, and contains albumen.

In a state of inflammation the mucous coat of the bladder, naturally soft, pale, and semi-transparent, becomes thick, rough, and of a reddish pink colour from the distension of a multitude of delicate blood-vessels, some of which give way and thus originate small spots of extravasation or echymosis. The inflammation may extend over the whole inner surface of the bladder, or be limited to some particular part of it—most commonly, that part which adjoins the neck of the bladder is found in a state of inflammation. The coagulable lymph which sometimes in these cases, covers the inner lining membrane has been found after death projecting in shreds into the cavity of the bladder; and during life portions of it having been occasionally separated and discharged by the urethra.

In Dr. Baillie's plate of ulceration of the mucous surface, the ulceration is shown to proceed from the fundus towards the neck. In a specimen which I possess, and in which only part of the membrane is destroyed, it commenced at the neck: and I have lately seen many specimens illustrating the same fact. In the examination of the bladder we should always remember that ulceration may be connected with the presence of a calculus.

I have seen a case, in which after death, the whole mucous membrane was found separated in a smooth greyish white continuous layer. It appeared to have sloughed away during life, and to have separated from the surrounding muscular tunics. At first it might have been taken for a false membrane of organized lymph; but upon closer inspection it was seen to possess traces of its normal structure. The bladder when first divided seemed to contain a large cyst or bag of hydatids; for the yellow membrane protruded through the cut surface, partially distended with urine. It was attached to the muscular coat both at the neck of the organ and at the entrance of the ureters, where the mucous membrane was red and congested, and more loosely connected than natural to the adjacent structures, but not deprived of vitality. Under the microscope there were to be seen the well marked fibres of areolar tissue, in which, however, the yellow elastic tissue prevailed ; the white fibres having in great part undergone decomposition. In most of the cases which I have dissected, the whole of the membrane has been removed by ulceration. Sometimes, however, round ulcerated spots, of the size of a sixpence, are found in different parts with elevated edges and a red surface, the muscular structure not being seen, and the remaining membrane being very vascular. The ulcers, when small, are not unlike primary syphilitic sores, by their excavated surfaces and raised margins.

If the inflammation reach a high degree, the muscular coat is also attacked, presenting here and there gangrenous spots, or even being completely destroyed by it. But, as the muscular is connected but loosely to the inner membrane of the bladder, the inflammation does not easily pass from one to the other. One of the kidneys is usually found diseased ; the pelvis and ureters may exhibit signs of ulceration ; they may be full of pus, and the latter also dilated and ulcerated at their vesical extremity.

This affection may be confounded with inflammation of the muscular structure ; but, in the latter case, there is not the power of passing urine, and the desire to void it is less frequent, as it is not experienced until a good deal of urine is accumulated in the bladder, and then comes on in violent paroxysms. Neither is there the burning sensation along the urethra which is felt when the mucous membrane is affected.

This disease is likely to be mistaken for stone. The uneasiness in the bladder, the frequent desire to make water, and the passage of blood with the urine, are symptoms of stone as well as of this disease. But in stone the pain is principally experienced after the bladder has been emptied, whereas, in acute inflammation of the mucous membrane of the bladder, the pain is most intense when the bladder contains urine, and it subsides when that viscus is empty : in stone, also, larger quantities of blood are passed than in this disease, and the urethra is seldom so irritable.

If the disease of the bladder co-exist, or be connected with organic mischief in the kidney, or of any other organ, little or no good will be derived from medical treatment. But as I am speaking of idiopathic inflammation of the mucous membrane of the bladder, I pass over cases occurring from such causes.

At the commencement, blood should be taken by cupping or the application of leeches to the hypogastric region, and this should be repeated so long as the severity of the pain continues, and the strength of the patient will permit. Commonly, however, the loss of much blood cannot be borne. At the early stage the most valuable remedy is morphine, or opium, (I prefer the former,) given in sufficient doses to allay the pain about the bladder and along the urethra, as well as the frequent desire to pass urine. These are the most distressing symptoms ; and if unmitigated, they soon wear out the strength of the patient ; but if even a few hours' intermission be obtained in the day, some chance may exist of recovery.

In addition to the internal use of opium, or morphine, anodyne injections, or suppositories, should be exhibited at bed-time ; and great relief will be experienced from their use. Some practitioners recommend the injection of oil and opium, and other remedies, into the bladder, by means of a gum-elastic catheter. In one of my patients, this plan had been tried at the suggestion of an eminent physician, prior to the patient being placed under my care : but no benefit was derived from the treatment. In fact, the pain and irritation caused by the introduction of any instrument along the urethra, are so severe, as to deter me from employing this method ; and unless there be retention of urine, the use of the catheter, sounds, and bougies, should be particularly avoided. It is advantageous to employ counter-irritation above the pubes ; and the hip-bath at night will be found very serviceable.

In the treatment of these cases, however, we find that no remedy, opium or morphine perhaps excepted, long retains any influence over the disease. The practitioner must be provided with a variety of agents, so as to be ready to substitute one for another when it loses its effect. Infusion of diosma in the proportion of an ounce to a pint of water, small doses of copaiba and essential oil of cubebs, infusion of hops and the alkalies, will, all in their turn, be found useful. Excepting at its commencement, mercury is not of use in this form of inflammation.

To the diet of the patient, the greatest attention should be paid. Animal food, wine, spirits, and acid drinks, should be interdicted ; the diet should be light, consisting of bland, farinaceous food ; and the drink should be water, toast-and-water, and linseed tea ; but not to such extent as to increase, in any very considerable degree, the secretion of urine. The patient should also be kept as quiet as possible, and in a rather warm temperature.

The prognosis of these cases is very unfavourable, if the ulcerative stage once sets in. This is usually indicated by the continuance of the pain of the bladder on motion, and in making water. If, therefore, the pain be not early subdued, little hope can be indulged of a successful termination. By judicious management, life may be prolonged for some time, but the patients are seldom cured, the bladder being in a state unfit to perform its functions, and the morbid changes having extended along the ureters to the kidneys. The inflammation spreading to the mucous lining of the ureters, the pelvis, and tubular structure of the kidney, is attended by a profuse secretion of mucus, purulent matter, and epithelium.

If a female (and females have been said to be more subject to this complaint than males) while labouring under the disease, becomes pregnant, the symptoms are greatly mitigated, and the fatal termination for a time averted. I examined the body of a French woman, who, immediately after delivery, was attacked with all the symptoms above mentioned, and died within a week from the attack. The inner membrane of the bladder was found to be completely destroyed. I could not obtain any accurate account of the case ; but I learnt that the patient, during the few days she was in the hospital prior to delivery, did not complain of the affection of the bladder. One case, however, I watched from the commencement of the disease (which occurred a month after marriage) till the death of the patient, which took place a month after delivery. During the latter half of pregnancy, the symptoms were much milder than before; but, soon after the birth of the child, they returned with their accustomed severity, and destroyed the patient.

I was requested to visit Mrs. M., æt. thirty-six, who was supposed to be labouring under symptoms of stone. She had frequent desire to make water, and shooting pains in the region of the bladder, much increased by walking, and exercise of every kind. The urine was acid, and contained some shreds of lymph or mucus. No blood or gravel had been passed. On sounding the patient, the instant the instrument was introduced into the urethra, the pain became much aggravated. No stone could be felt. The pulse was small and quick, the skin dry and rough, the tongue white, the countenance anxious, and indicative of much suffering. I expressed a very unfavourable opinion of the case, believing, as I then stated, that there was ulceration of the bladder. She had been in this state two months, and various remedies had been tried. I suggested the use of pareira brava, first in the form of infusion, then in that of decoction. For the first six weeks leeches were occasionally applied to the hypogastric region, tartar emetic ointment rubbed in, and at night, a thin starch injection, with twenty minims of Battley's sedative solution, was given. Mrs. M. then tried the decoction of pareira brava, which she continued till about two months prior to her death, when, perceiving more mucus in the urine than usual, and occasionally blood, I added a small quantity of balsam of copaiva to the mixture. This brought on sickness and deranged the stomach so much that thenceforward she was obliged to desist from the decoction. She now had sickness and nausea; pus was voided with the urine; there was complete loss of strength, emaciation of her body, and hectic flushes; and six months from the time I first visited her, death put an end to her sufferings. It should be observed that, for a few days prior to death, no pus had been voided with the urine, and the pain and frequent desire to make water, for the only time during her long illness, had almost subsided.

The body was examined within forty-eight hours after death. The bladder was not thickened or contracted, but completely divested of its mucous membrane. No dissection could exhibit the arrangement of the muscular structure so well as it was seen in this case. One spot the size of a shilling, towards the fundus was black, and almost gangrenous. The ulceration had not extended to the urethra; but its lining membrane was highly inflamed. The right kidney was in its natural state, but there was ulceration of the left kidney, and its interior was filled with pus. The renal extremity of the left ureter was blocked up by a detached portion of the substance of the kidney.

Deborah Mulloday, aged forty-six, complained of great uneasiness, pain in the lower part of the belly, and frequent desire to void urine. After the bladder was emptied, the pain and uneasiness usually subsided. These symptoms were at first relieved by the use of the decoction of pareira brava. The pain became very acute, the desire to make water more frequent; the urine contained a good deal of pus; and, on two or three occasions, it was tinged with blood. The pulse was small and quick; the countenance pale and sallow;

and there was emaciation of the body, with occasional shiverings and cramps. She had no pain in the loins, and there was no sickness until about ten days prior to her death, when it was very distressing, and of some days' continuance. On Friday, July 26, she was seized with paralysis, and expired on the following Tuesday. Twenty-four hours after death the body was examined. The mucous membrane of the bladder was ulcerated in several spots, but was not so extensively destroyed as in the preceding case. The bladder, which was thickened and contracted, contained a good deal of pus. The vesical extremity of the left ureter was ulcerated; the substance of the left kidney in some parts was completely destroyed by ulceration, and its pelvis full of pus. The right kidney was in a state of atrophy, and its interior contained a deposition of chalky matter. The urethra was inflamed, but not ulcerated.

George Scandreth, æt. fifty-six, tailor, complained of frequent desire to pass urine, of great pain in passing it, a scalding sensation in the urethra, and of pain above the pubes and across the loins. The urine was high-coloured, and contained numerous fine shreds of lymph; it was also acid, scanty, and albuminous. I ordered some soothing remedies which, for a time, diminished the pain, but had no other effect on the disease. The patient became gradually worse; and in two months he died. On examination, I found the mucous membrane of the bladder almost completely destroyed, minute filaments hanging loosely from its inner surface; the bladder contracted in size, and a little thickened; the lining membrane of the urethra highly inflamed and ulcerated about the membranous portion; the prostate not enlarged; the left kidney in a state of ulceration, and containing pus. I have the preparation in my possession.

William David Sadler, aged seventeen, of a delicate constitution, and light complexion, applied at the General Dispensary for an affection of the bladder. He said that about seven months previously, in making water, he first felt pain, which lasted for some minutes, and then went away. Since that time, this symptom had never left him. Occasionally he was suddenly seized with a darting pain near the neck of the bladder, accompanied with an irresistible desire to make water, after which the pain subsided, and he felt easier. These attacks varied in frequency—sometimes they occurred every hour or oftener, at other times at longer intervals. The urine was turbid, voided in small quantities, and extremely acid. The appetite was good; the general health not much deranged; the pulse quick; the tongue white and dry. Two or three times a sound was introduced, with great pain, but no stone could be felt. Alkalies and hyoscyamus; small doses of cubebs, with carbonate of potash; the decoction of pareira brava alone, and in combination with small doses of copaiba, mucilage, and hyoscyamus, were tried; but without benefit.

The patient escaped from my notice; but he died a short time afterwards, and I was informed by the medical man who examined the body, that there was ulceration of the bladder, and disease of the left kidney.

Charlotte Mason, æt. fifty-six, a married woman without family, and subject to pains in the limbs, was seized, in the month of March, with a frequent desire to void urine, always attended with great pain, and a burning heat in the urethra; the pain continued for some time after the urine was passed, so that she could scarcely stand or sit down; she had great pain in her back and the lower part of the abdomen, headache, and at times pains in the left hip and leg, great weakness, trembling, and general debility. During the night she was generally obliged to micturate four or five times: the urine was alkaline, of a light straw colour, and latterly contained a good deal of pus. The disease resisted all the remedies which I could devise. Morphine alone gave her relief. She gradually lost flesh and strength, and died on the 30th of the following December. I examined the body, and found the whole of the mucous membrane completely destroyed by ulceration. The left kidney was also in a state of ulceration, and the lining membrane of the left ureter, to the extent of two or three inches, close to its vesical extremity, thickened and lined with coagulable lymph.

Dr. Prout, in alluding to these cases, considers them nearly allied to irritable bladder dependent on organic mischief in the kidney. "The urine in these cases," says Dr. P. "is generally acid, of a pale greenish whey-like colour; opalescent, from the presence of minute epithelium or mucus; of low specific gravity; (that is, generally below 1.020; often serous, but rarely bloody. Sometimes, on being heated, it deposits the phosphates; but the urate of ammonia is seldom so abundant as to be spontaneously separated on the cooling of the urine; and when this circumstance does take place, the colour of the sediment, instead of being yellow or red, is usually of a greyish ash tint. After standing for some time, the urine becomes clearer, but seldom acquires perfect transparency, even by filtering ; and the peculiar sediment in general is very easily remixed on shaking.

" In conjunction with these appearances of the urine, the patient usually complains of the following symptoms : there is a frequent and urgent desire to pass water, the period varying from one to three hours, and the quantity from one to two or three ounces, both by night and by day. At the moment of passing water, and for some time afterwards, there is an uneasiness, sometimes amounting to severe pain, felt along the whole of the urethra, but particularly just behind the scrotum ; and of this uneasiness or pain, a sense of burning or scalding is one of the elements. There is no mechanical impediment to passing the water ; and in the earlier stages, after a short time, the whole uneasiness subsides, and the patient remains quite well till the period arrives when he is called upon, as before, to empty the bladder. As the disease advances, all these symptoms become augmented. The unnatural properties of the urine, and of the mucous deposit, increase ; the symptoms, and particularly the calls to pass the urine, are more urgent and frequent ; the general health and strength, which from the commencement had been disordered and enfeebled, now daily decline, and the patient becomes emaciated, weak, and irritable, and more than ever susceptible of the influence of atmospheric changes. During the whole of this period there is but little uneasiness felt in the region of the kidneys, and what little there may be, is usually referred to weakness. On minute inquiry, patients will sometimes admit the existence of a dull aching sensation in the loins, and occasional darting pains down the course of the ureter, and even to the testicles, &c. ; but these are so trifling compared with the bladder sensations, that they are seldom complained of, unless particularly inquired after. The termination of the complaint is various ; most frequently perhaps as follows :

" The pulse gradually becomes more weak and feeble, and the stomach, from being weak and disordered, often rejects what is taken, so that the patient is very apt to be sick after eating. At the same time the urine, though not improved in quality, is diminished in quantity, and the calls to pass it are in consequence less frequent. The patient complains of nothing, but he daily becomes more indifferent and drowsy ; as the sickness increases, the urine is still further diminished in quantity ; at length everything is rejected, the secretion of the urine ceases altogether, and the patient expires, generally in a comatose state. Occasionally the termination is more sudden and unexpected ; and in such instances inflammatory symptoms have been generally superinduced from exposure to cold or some other exciting cause. Now and then the patient becomes phthisical—in short, the fatal termination, though always certain, may be various, and depend upon the peculiarities of the patient's constitution, and accidental circumstances.

" Several of the cases described by Mr. Coulson, under the denomination of acute inflammation of the mucous membrane of the bladder, seem to me to be nearly allied to this form of disease. I have reason to believe that the present disease often exists for years in a chronic form, and confined chiefly to the kidney: that when the degenerating process reaches and attacks the bladder, it sometimes assumes, either spontaneously or from accidental circumstances, a more acute form, and terminates fatally like those described by Mr. C., with complete destruction of the mucous membrane of the bladder, &c."

There is one mark of distinction between the affection which I have described and irritable bladder dependent on organic affection of the kidney so striking, as to have enabled me hitherto to determine with tolerable accuracy, the existence of the diseases:—I mean the intense pain which attends inflammation and ulceration of the mucous membrane of the bladder, and soon exhausts the strength of the patient. Now in irritable bladder dependent on organic affection of the kidney, there is sometimes but not always pain in passing the urine; the frequency of making water is the most distressing symptom, and even when pain exists, it is never so severe as to wear the patient out, but may be, and frequently is, endured for years. The intensity of the pain and the rapid exhaustion of the vital powers, mark the distinction between the two classes of cases.

CHAPTER VI.

CHRONIC INFLAMMATION OF THE MUCOUS MEMBRANE OF THE BLADDER.

Men are more subject to this complaint than women, and elderly persons than young ones. In some countries the disease appears to be uncommon, as Hoffmann calls it *morbus rarissimus.* In others, it occurs more frequently, and something like it has been known to assume an epidemic character.

The discharge of mucus is the great characteristic of the disease ; and hence the term *vesical catarrh.* This is accompanied by a sensation of heat in the bladder, extending along the urethra, and of weight in the perineum, shooting pains towards the anus, and frequent desire to void urine, though not in so great a degree as in acute inflammation.

Sometimes the symptoms are very mild, and cause but little inconvenience ; at other times, the disease assumes a serious character, and even proves fatal, especially in old and weak persons. Then, the expulsion of the urine, but more particularly that of the last few ounces, is more or less painful, according to the violence of the contractions of the bladder and abdominal muscles. The heat in the bladder and urethra are converted into scalding; the desire to make water becomes more frequent, and is attended with violent straining efforts to void it; and retention, usually caused by clots of mucus blocking up the passage, often takes place. On the urine being drawn off, the symptoms are relieved for a time; but they return on the filling of the bladder.

The patient is very restless and uneasy; there is great thirst; the bowels are irregular, generally very costive or relaxed; there exists pain at the extremity of the penis round the anus, and in the region of the loins; there are great prostration of strength and wasting of flesh.

The quantity of mucus secreted varies: sometimes it is small; at other times it is considerable; and cases are recorded, in which several pounds were passed during the twenty-four hours. Small quantities of the mucus thus coming away render the urine muddy, pale, and flaky, and afterwards settle to the bottom of the vessel. The mucus, (*Soemmering, Uber die Krankeiten der Harnblase,*) however, is sometimes like panada, and being shaken, colours the urine without flakes: at other times it is stringy, flaky, and of a lumpy consistence. It has been so glutinous, as, on pouring it out of one vessel into another, to be drawn out above a foot in length, without rending. Sometimes, it is transparent, white, yellow, green, with streaks of blue, often without smell; sometimes, on the contrary, it is dreadfully fœtid. Blood and pus are often passed with the mucus in this disease.

When the properties of the mucus are but little changed, it diffuses itself throughout the urine for a time, and renders it turbid and of whitish colour, but it afterwards subsides to the bottom, and leaves the urine to assume its usual hue. Commonly it is thick, viscid, and ropy, and sinks to the bottom of the vessel at once : in this case, the urine is of a dark brown colour, and is either neutral or alkalescent. The urine, however, is usually acid at the commencement, and continues so until the quantity of mucus secreted is great : in this case especially, if the patients are very feeble, the urine is alkaline or neutral.

If the mucus comes away in large quantities, and is at the same time glutinous, it requires an effort to discharge it, and it often occasions retention. After voiding it, the burning sensation in the region of the bladder ceases, but gradually returns as the mucus again collects. If the secretion of mucus be copious, the patient becomes hectic, and at last sinks from exhaustion.

Prout states that in the advanced stage of the disease the urine undergoes very important changes. The quantity of mucus (in its ropy state at least) is perceptibly diminished ; the mucus also becomes opalescent and of a greenish tint, and is not only less tenacious, but can in part be easily diffused through the urine, rendering it glairy, or opake and milky, like pus ; in short, the urine becomes muco-purulent. The urine is now generally deep coloured or serous and alkalescent. When alkalescent it has generally a strong ammoniacal smell, and effervesces with an acid, and in this case there is almost always an excess of carbonate of potash or of soda present, derived from the serum of the blood. When these symptoms have continued for a greater or less period, the urine becomes scanty, still more high coloured, and occasionally even acid ; the mucus and even the pus gradually diminish and almost disappear ; and after a short period of comparative ease, the patient expires.

In the commencement, the mucous membrane, usually pale, becomes dotted and streaked with blood, which in part is contained in dilated blood-vessels, and part is extravasated. These spots are generally black, the blood having lost its normal colour. As the disease goes on, the discoloration becomes more general and deeper ; the membrane is thickened, softened and flocculent ; it tears readily from the muscular coat and is found abraded, especially in the neighbourhood of some large extravasation. The disease spreads along the mucous lining of the ureters and the tubular structure of the kidneys. The canals become filled with a muco-purulent fluid, and pyelitis may occur. The muscular coat of the bladder becomes thickened ; ulceration takes place in the mucous membrane, which, as in acute inflammation, may be entirely removed, leaving exposed the hypertrophied muscular fibres and constituting what the French term " la vessie à columnes," from the resemblance these columns bear to the columnæ carneæ of the heart.

The most prominent portions of these folds are usually of a blue or purplish red colour ; while between them, the membrane is pale, swollen, soft, and offering little resistance ; occasionally small ulcerations are found. But what is very remarkable, between the folds, pouches or sacs generally co-exist with dilated ureters, both being produced by the same physical cause, (forced distension,) in consequence of prolonged difficulty in expelling the urine ; the formation of the former may be explained in the following manner :—The contraction of the abdominal muscles, as well as of the bladder itself, when full of urine, forces portions of the lining membrane of this organ between the muscular fibres, and thus sacs or pouches are formed, and these pouches being lined by a diseased mucous membrane, secreting an alkaline mucus, sometimes become the receptacle of mortar-like matter, and, finally, of calculi, consisting generally of phosphate of lime.

I have, on more than one occasion, seen the secreting structure of the kidney reduced to a thin layer, covering the widely dilated pelvis and infundibula. The ureter proceeding thence has been both dilated and tortuous, and the lining membrane rough and granular, in some instances covered by flakes of lymph. The urine when first passed is white and more opaque than natural, from the admixture of mucus and epithelium ; but after standing for a time, its transparency is in part restored from the subsidence of the mucus to the bottom of the vessel. When tested it has an acid reaction, although the morbid secretion with which it is mixed is alkaline.

In the severe form of the disease, all the muscular fibres of the bladder are much enlarged, thickened, and occasionally covered here and there with calcareous deposits. I have, in my possession, a bladder taken from a man who had long suffered from vesical catarrh, presenting this appearance. The fundus of the bladder is usually most diseased, but the whole of it is thickened, contracted, and harder than natural, and its mucous membrane is purplish, injected, and presents many folds or columns of greater or less thickness, according to the period of the disease and their situation. They are always longest and largest at the fundus.

It has been said that when vesical mucus is passed in small quantity, the disorder may be mistaken for an involuntary evacuation of semen, which accompanies in some persons the escape of the urine and fæces. These two fluids are analogous by their viscid and alkaline properties, and the substances which compose them ; but semen differs essentially from mucus by its colour, by the property which it has of liquifying on cooling, by its insolubility in water when thick, and its solubility on the contrary when it is liquid, and especially by the radiating crystals which it produces after slight evaporation.

The urine in this disorder may be also distinguished from chylous urine, because the latter, immediately it is passed, presents a whitish appearance, and the sediment, on shaking, mixes with the urine ; on the contrary, the urine in vesical catarrh is at first turbid ; on standing, the sediment becomes viscid, ropy, and flocculent, or united into one clot.

The exciting causes of catarrh of the bladder, are stricture, stone, enlargement of the prostate, exposure to cold, indulgence in ardent spirits, diuretic and irritating remedies, such as cantharides, violent exercise on horseback, venereal excesses, and it exists in connexion with hæmorrhoids, and other diseases of the rectum. In injuries and diseases of the spine, this state of the bladder usually occurs.

When this disease co-exists with stricture of the urethra, or is produced by it, it is extremely difficult of treatment. The pain and irritation along the urethra are often so great as to render the use of catheters and bougies impracticable; and, unless the state of the urethra improve, no material benefit can be expected from internal remedies. Under these circumstances, free use must at first be made of sedatives; and, when the pain and irritation of the urethra have subsided, this canal must be dilated with bougies or the gum-elastic catheter. If the stricture be of long standing and very narrow, I commence with armed bougies, introducing them once in three or four days, and in very few cases have I failed, by this means, in dilating the urethra.

There are some habits apparently more predisposed to this affection than others: such are those of irritable scrofulous temperaments, with fair skin, and tendency to cutaneous affections, more especially if accustomed to live freely, or given to venereal excesses, or have suffered from syphilitic affections, or gout. In such individuals, exposure to cold seems the most frequent exciting causes of this affection, and those who actually labour under it, generally suffer much more severely in cold weather. Gouty persons are very subject to this affection.

Cases of milder character have been observed to terminate in a short time, or to assume an intermittent form, especially when associated with hæmorrhoids, or certain petechial affections; but the duration of this complaint is uncertain. Old persons mostly retain it as long as they live. The catheter, even if there be no retention, must occasionally be employed; but in severe cases, retention generally exists, and the water should be drawn off twice or oftener in twenty-four hours.

Nitric-acid injections are of great use in cases where the effects of the disease are local; the general health not being much impaired, and the patient feeling comparatively well when the scalding and pain after passing urine have subsided. In cases also where the internal administration of acids appears to have no effect on the secretion of mucus, the injection of acid is of great service. The following case strikingly illustrates the beneficial effects of acid-injection.

Mr. F., æt. sixty-seven, slightly rheumatic, consulted me, April 7, on account of an affection of the bladder. He complained of frequent desire to make water, with severe pain and scalding along the urethra, just before and during its passage, and of uneasiness or sense of weight above the pubes. He had occasional retention, and was frequently compelled to pass a catheter to draw off the urine. The disease was brought on by retaining the urine on one occasion, after the desire to void it had come on. There was no enlargement of the prostate, nor any stricture. The urine was alkaline, and contained a considerable quantity of mucus, which was of a dirty white colour, and sank to the bottom of the vessel; it was stringy, and on being shaken with the urine did not mix: it was free from blood. The urine, on being passed, had a slight ammoniacal smell; but this became very strong on standing twenty-four hours. Its specific gravity was 1·015. His general health was not impaired; and he felt pretty well when the burning pain, which attended the passing of urine had subsided until a fresh desire came on.—I tried the decoction of pareira brava, with the dilute nitric acid and sedatives, without any relief whatever.

May 8th.—The quantity of mucus with the phosphatic deposits increasing, I recommended the injection of the bladder, first throwing in, by means of a gum-elastic syringe and catheter, four ounces of decoction of poppy ; and, on withdrawing this, four ounces of water, containing two minims of strong nitric acid. I kept this in for two or three minutes, and withdrew it. He took half a grain of morphium immediately after the injection. The symptoms were a little, but not materially, improved by the injection.

May 10th.—I injected ten ounces of distilled water with one minim of the strong nitric acid to the ounce of water (five ounces at each injection), and caused each quantity to be retained for two or three minutes, until he complained of slight pain or uneasiness.

May 12th.—The symptoms and condition of the urine were slightly improved. I injected ten ounces of distilled water, with two minims of the strong nitric acid to each ounce of water, in the same manner as before. This injection was followed by considerable pain, which continued several hours ; but, on the following day, the urine was much changed in appearance, contained little or no mucus, and had lost its dark-brown colour. The irritability of the bladder was considerably lessened. I injected the bladder twice after this, but with a smaller proportion of acid ; the urine which had been alkaline became acid, and the patient lost all his bad symptoms.

"In aggravated cases of the disease," says Sir B. Brodie, "where the symptoms are at their greatest height, the mildest injections, even those of tepid water, will do harm rather than good. They are especially to be avoided when the mucus deposited by the urine is highly tinged with blood. When, however, the symptoms have in some degree abated, the injection of tepid water, or decoction of poppies is, in many instances, productive of excellent effects. An elastic gum-catheter may be introduced into the bladder ; and the injection may be made by means of an elastic-gum syringe. The liquid should be allowed to remain in the bladder about thirty or forty seconds ; and not more than an ounce and a half or two ounces should be injected each time. If the bladder be distended, so as to occasion any considerable degree of pain, the effect is always injurious, instead of being beneficial. This operation may be repeated, according to circumstances, once or twice in twenty-four hours. When there is a further abatement of the symptoms, the disease having assumed a still more chronic form, and the mucus being free, except on extraordinary occasions, from all admixture of blood, we may venture to add to the injection a very small quantity of nitric acid. At first, the proportion ought not to be more than that of one minim of the concentrated, or ten minims of the diluted, nitric acid, to two ounces of distilled water ; but afterwards this proportion may be doubled."

The tenacious mucus produced in this state of the bladder deposits phosphate of lime; and when phosphate of lime from this source coexists, as it often does, with the triple phosphate in the urine, a compound salt is formed. In such cases, a weak solution of nitric acid (beginning with a drop, and gradually increasing it to two, of concentrated nitric acid to two ounces of distilled water), if injected into the bladder, acts as a salutary astringent. I use the same apparatus for acid injections as for injecting the bladder in lithotrity, as the minute quantity of the acid is not likely to act on the nickel-silver of which these instruments are composed.

Professor Lallemand * has successfully practised cauterization of the mucous membrane of the bladder in chronic catarrh, with solid nitrate of silver. The following is his mode of employing this remedy:—He uses a large catheter (of pure silver, as the caustic acts upon it if there is any alloy) open at both ends, having two sorts of stilet, according to the part intended to be cauterized; at the extremity of each stilet is a small excavation, containing the caustic, which is first pulverised, and then placed in the excavation over a spirit-lamp, which fuses and moulds it to the cavity.

When the instrument is prepared, an ordinary catheter must be introduced into the bladder in order to empty it completely. This precaution is strictly necessary, for the urine would dissolve the caustic, and prevent its directly affecting the mucous membrane. When this has

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* I am indebted for this information to an able paper on Chronic Cystitis, by Dr. O'Bryen, in the *Dublin Journal of Medical Science*, September, 1838.

been withdrawn, the instrument bearing the caustic is to be introduced (closed), and the moment it has entered the bladder, you are to push the stilet, and rapidly turn the porte caustique from side to side two or three times, and then pull the stilet into the instrument, and withdraw it; our object should be to touch the surface in as many points as possible. While the instrument is within the bladder, the latter contracts and grasps it, while the kidneys secrete a small quantity of urine, as the lachrymal gland secretes tears when the conjunctiva is cauterized; but this small quantity of liquid, far from being hurtful, is on the contrary favourable, as it acts as a vehicle to the part it does not decompose, and conveys it equally over the surface of the membrane. Patients feel, at that moment, a sharp pain at the neck of the bladder, and in the rectum, described by them as if they were pinched, but much more supportable than the continued dull pain of chronic catarrh; there is now an irresistible desire to pass water, and as the bladder is nearly empty very little is voided, and this causes a burning along the urethra, often accompanied by some drops of blood. This desire is renewed every moment, causing violent but useless efforts. These gradually decrease, and on the second and third day, there is no longer any pain on making water, and a few small grey eschars, like burned paper, come away with the urine. This occurs in a large number of patients, but in some more susceptible, the process does not proceed so simply, particularly if you have used the porte caustique too long. In this case retention of urine follows, which lasts from three to thirty-six hours; even here we must not be in too great a hurry to use the catheter, as a warm bath, a few narcotic lavements, emollient drinks, some tartrate of soda with infus. sennæ, and sometimes a few leeches, will cause the spasms to yield; if not, some belladonna to the meatus may be tried, always taking care to use antiphlogistics with moderation in the beginning, as inflammation is necessary to the cure. In a majority of cases one cauterization is sufficient to effect a cure; when it happens otherwise, a second and even a third application may be necessary, but Lallemand states that he never saw a case requiring a fourth.

Dr. Devergie * has recorded eight cases of chronic catarrh, some of long standing, which were cured by injecting balsam of copaiba into the bladder. Some of these cases had gradually manifested itself, and maintained throughout its chronic character. A moderate quantity of an emollient fluid must first be injected, to ascertain the capacity of the bladder, but not in sufficient quantity to irritate it. General means must be resorted to, to calm the inflammation and local pain, the general erethism, &c. Narcotics must next be added to the emollient injections; and these may be repeated three or four times a-day. When the irritation of the bladder and neighbouring parts is allayed, the copaiba should be injected. A dose of uniform strength is not suited to every case. A drachm of balsam of copaiba to an ounce of barley-water is strong enough to commence with; the quantity of balsam may

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* Gazette Médicale de Paris, and British and Foreign Medical Review.

be increased according to its effects. The combination of narcotics with copaiba renders the latter less exciting. The balsamic injections may be allowed to remain in the bladder for a period of from ten to twenty minutes. The quantity of copaiba is to be gradually augmented ; and it should not be injected more frequently than once daily, nor intermitted more than two days. The injection is to be continued until the muco-purulent secretion has quite ceased. It is necessary to guard against the occurrence of inflammation of the mucous membrane of the alimentary canal, and, under such a circumstance, to suspend the use of the balsamic injections.

In these cases Chopart recommended injection of the bladder ; and he mentions the case of a man sixty-five years of age, almost worn out by excessive secretion of mucus, who was cured by this means.

The medicines found most serviceable where there is much secretion of mucus, are the decoction of uva ursi, with the muriated tincture of iron, and small doses of powdered galls and nitre. If there be much pain and irritability of the bladder, the decoction of pareira brava is an excellent medicine ; and it may be combined with nitric or nitro-muriatic acid, or dilute phosphoric acid, to lessen the secretion of mucus. If there be much pain and restlessness, morphium or opium ought on no account to be omitted. Barthez mentions a case in which fifteen pounds of mucus were passed in thirty-six hours, and which was cured solely by the exhibition of large doses of opium internally, and in the form of clyster.

If there is any constitutional tendency to gout, colchicum should be administered. The form in which I am in the habit of giving it is the acetous extract, in the dose of one or two grains at bed-time. In these cases, small doses of copaiba, or of the essential oil of cubebs, with hyoscyamus, will often do great good, and may either be added to the infusion of buchu, or decoction of pareira brava, or be given alone. Some surgeons put great confidence in copaiba in the treatment of this disease. Sir A. Cooper says,—"The best remedy that can possibly be taken is the balsam of copaiba; no medicine so completely robs the urine of mucus as this. Eight or ten drops three times a day will usually be found quite sufficient; it may be given in conjunction with sweet spirits of nitre and camphor mixture, or in ʒij. mucilag. gum. acaciæ, et ʒx. aq. font."

Copaiba may be given with advantage in combination with small doses of zinc, chio turpentine, or sulphate of iron; but whatever other remedies may be used, the surgeon must not omit the use of morphium or opium once or oftener in the twenty-four hours. Dupuytren used to rely very much on turpentine in this disease. But both cubebs and copaiba must be administered with care; for, after the long-continued use of these medicines, chronic inflammation of the bladder sometimes comes on. I am frequently in the habit of giving the tinctura benzoini composita (in the dose of a teaspoonful) three times a day, with considerable relief to the patient. When the urine is alkaline, and contains a good deal of mucus with the phosphates, the alchimella arvensis may be administered with advantage. An ounce of the dried plant is to be infused in a pint of boiling water for three or four hours; and two ounces of the infusion are to be taken three times a day. I need not say that in this complaint, blood-letting is seldom required. In the severer form, where there is great depression of the vital powers, the patient should be sustained with light nourishment, and small quantities of wine given from time to time. In the milder form, patients may be allowed to take animal food; but beer, wine, and spirits, must be strictly prohibited. Patients must also be cautioned against irregularities of every kind, and must be told the consequences of neglecting the advice given them. From want of care on the patient's part, the mild has often assumed the severe form, and an attack of acute inflammation has come on and destroyed life.

I attended an elderly person, who, for some time previous, had been subject to occasional difficulty in passing urine, and to the discharge of mucus, which latterly had much increased. When I saw him, there was frequent desire to make water, attended with great uneasiness and pain in the lower part of the abdomen, sense of burning in the urethra, inability to micturate, cramps in the legs, thirst, and slight shivering. On drawing off the water, these symptoms subsided for a time; but they invariably returned on the filling of the bladder. The urine was acid, of a dark brown colour, and contained a great quantity of mucus more of an amber colour than any other. This always subsided to the bottom of the vessel, was very tenacious on being everted, and could be drawn into long strings. Sometimes this mucus would come out in clots, and it was occasionally streaked with blood, and very offensive to the smell. On exposing some of it to the action of cold for a few hours, it became quite dense.—Morphium, the decoction of uva ursi, with the ammoniated tincture of iron, the decoction of pareira brava, lavements, and the regular introduction of the catheter, were employed, but without avail; the patient's strength gradually declined; and he sank at the end of six weeks. There was no post-mortem examination.

The following interesting case occurred in the practice of Dr. Elliotson. For a great number of years, the individual had laboured under cystorrhœa, as it is sometimes called, or a discharge of mucus from the bladder. A great quantity of mucus was constantly deposited in the vessel which he used; and that it was true mucus was evident, from its capability of being drawn out into long threads. This continued for a number of years, and various remedies were used; but they were all rendered useless by his taking an excessive degree of exercise. Any remedy, however, that was at all irritating, did him a great deal of harm: mild means only were suited to him. The consequence of not taking care of himself, and of taking considerable exercise, was, that what at first was a mere increased secretion of the bladder, became at last an organic disease of that viscus, slow inflammation, hypertrophy, and finally, pretty active inflammation.

The following were the morbid appearances found on dissection:—The bladder was amazingly thickened: its substance was in a high state of hypertrophy, the muscular fibres being considerably increased in size. There was a very considerable hypertrophy of the muscular coat, mucous membrane, &c., at the part corresponding with the trigone vesicale; so that a large transverse fold was formed by it. This person had from 300 to 400 small stones in the gall-bladder, but he never suffered any inconvenience from them, and their presence was unexpected. He had no stone, no stricture, no difficulty in passing water, but an excessive discharge from the interior of the bladder, for many years. From its rugousness, the interior of the bladder might be compared to the interior of the stomach. The symptoms preceding death were agonising pain, a constant desire to make water, a discharge of blood as well as of mucus, which at last was rather pus than mucus. From excessive secretion, there came on chronic inflammation of the substance of the bladder; and finally, that chronic inflammation became acute, and destroyed the patient.

CHAPTER VII.

ACUTE INFLAMMATION OF THE MUSCULAR STRUCTURE OF THE BLADDER.

Some authors suppose that the muscular structure of the bladder is never inflamed alone, but that its peritoneal and mucous membrane always at the same time partake of the inflammatory action. Mr. Howship* says, "An acute inflammatory action of the bladder is, I believe, never confined entirely to the muscular coat. Either the mucous membrane within, or the peritoneal covering without, or both, have been always, as far as I have seen, more or less, involved in the same state, and consequently the phenomena of irritation become blended with the symptoms of inflammation." Boyer likewise says, "Inflammation of the bladder, like that of all organs composed of several tunics and lined by a mucous membrane, may attack all the tunics at once, or only the internal coat. The first case is termed inflammation of the bladder or cystitis; the second, catarrhal inflammation, or catarrh of the bladder. At all events, it is right to observe, that, in cystitis, the mucous membrane partakes, more or less, of the inflammation; and that, in acute and very intense catarrh of the bladder, the other membranes of the viscus are also inflamed. Hence, without doubt, the difficulty in several cases of distinguishing the symptoms of inflammation of the mucous membrane, from those which belong to the inflamed state of the other membranes." "We must say," observes Mr. Johnson,* "that we have never seen a case in which we were satisfied of the limitation of the inflammation to this coat. That inflammation may, in one instance, be principally seated in one tunic, and that, in another instance, it may be mainly located in another, is too certain to admit of doubt; but its absolute limitation to one coat, and particularly to a central coat like the muscular, does not seem to us so well established in fact as in theory." Mr. Wilson, on the contrary, in his lectures on the urinary organs, says, "Inflammation may arise from various causes, affecting the whole of the coats; or it may arise from a cause acting only on one, and may be confined to that single coat." Dr. Prout † says, "Authors speak of inflammation, both acute and chronic, of the muscular structure of the bladder. We also read of rheumatic and gouty inflammation of this organ. I have been informed that rheumatic or neuralgic affections of the bladder are well known, and not unfrequent in malaria districts bordering on the tropics; and I believe that I have seen a few instances of such affections, in this country. In such cases it is probable that the muscular and nervous structures and their appendages are the chief seat of the affection. With respect to the existence of gouty inflammation of the bladder, I believe there cannot be two opinions; and if we take the matter for granted, we must suppose that such inflammation attacks in preference that peculiar structure of the bladder, which is analogous to, or identical with, the structure attacked by gouty inflammation in other parts of the body. Whether the mucous membrane be the structure primarily attacked by gouty inflammation, I do not know; I believe it is not; but that, like the skin in other parts of the body, the mucous membrane (as in cystorrhœa for instance) is only secondarily affected. So far I am willing to allow, that inflammatory excitement, or something which we must denominate inflammatory excitement, may chiefly be confined to the muscular and nearly allied structures of the bladder. I can also understand how ordinary inflammation may involve these structures in common with the rest of the structures of the bladder, but I confess that at present I am quite unacquainted with, and indeed doubt, the existence of the commencement, and particularly the limitation of ordinary inflammation to the muscular structure of this organ." Now, the fact I take to be this—inflammation may confine itself to the mucous tunic, or it may limit its action to the peritoneal covering of the bladder; but with respect to the muscular coat of this viscus, I am of opinion that it is seldom, perhaps never, exclusively the seat of inflammation, if we except those cases in which abscesses form between the serous and muscular coverings. Morbid anatomy proves to us that inflammation may arise in this situation, and that the walls of the organ become thickened, and pus is secreted in one or more cysts, which in course of time burst through the mucous membrane and open into the vesical cavity. The muscular structure in these spots is wasted and in great part destroyed, a few stray fibres only being found about the walls of the abscess. But perhaps it would be more correct to regard the areolar tissue, and not the muscular fibres, as the seat of inflammation; in short, to class the affection as we should class an abscess occurring in any other situation. From these central structures inflammation has a great tendency to spread both outwardly and inwardly; and hence it is that we never observe the former to be much inflamed, without finding either or both of the latter more or less involved in the morbid action. Vogel even says, "Nulla fere fit hujus morbi a recentioribus autoribus mentio." It more frequently attacks adults than the young or old, and strong robust persons than delicate ones. It is also more common in males than females, whilst the contrary is the case as to acute inflammation of the mucous membrane.

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* On the Secretion and Excretion of Urine, p. 230.

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* Medico-Chirurgical Review.

† Op. cit. p. 378.

The patient first complains of a dull aching pain in the region of the bladder, which soon becomes more violent, and extends to the neighbouring organs. This pain is increased by pressure, and is attended by desire to pass urine, without the power to accomplish it. The desire comes on in paroxysms, attended with pain; the urine is at first evacuated in small quantities; and the attempt to pass it causes great pain. The small quantity which escapes is of a dark colour, sometimes not unlike coffee in appearance; at other times it is of a deep red, and even blood colour; and at last complete retention occurs. There is a sense of fulness in the lower part of the abdomen, and pains in the lumbar region, in the groins and down the thighs; but there is not the burning sensation along the urethra and in the perineum which exists in inflammation of the mucous membrane.

The disease is ushered in by rigors, which are soon succeeded by great constitutional disturbance. The pulse is full and hard, the thirst great, and the skin hot, with general uneasiness and sickness. If the inflammation increase, pains are felt in the intestines, particularly in the rectum, combined with tenesmus; delirium comes on; the pulse rapidly sinks; and the patient soon dies.

If the inflammation should be seated in the neck of the bladder, as is frequently the case, the urine which has entered the bladder, is retained by the tumefaction ensuing from the inflammatory action, and the bladder soon becomes distended and projects above the pubes. There is a sense of weight in the perineum; there are often painful erections of the penis; and examination by the rectum gives great pain.

The anatomical structure of this part readily accounts for these symptoms. The triangular space is at once very vascular and highly sensitive;* its nerves, arising from the third and fourth sacral pairs, as well as from the great sympathetic, descend on each side through the inferior mesenteric and the hypogastric plexus, and communicate more particularly upon this space. We have, therefore, only to recollect the relative connexions and ramifications of these different nerves to be able to explain, not merely the strong and constant desire to evacuate the bladder that prevails when this part of the bladder is irritated or inflamed, but also the remote symptoms with which this inflammation is liable to be accompanied.

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* With regard to the urethral opening of the bladder, Mr. Guthrie observes, "that fibres have been described surrounding this part, though no anatomist has demonstrated them so as to warrant their being called a sphincter muscle; that this part may be both muscular and elastic, but that the older anatomists supposed the power which prevented the flow of urine to reside in other muscles surrounding the membranous part of the urethra."

If the inflammation exists somewhat higher up in the bladder, where the ureters enter, the orifices of the latter become contracted, and the bladder being closed against the influx of the urine, the ureters become enormously distended. The orifice of the ureters is surrounded by a dense elastic substance, which lies between the muscular and the mucous coats of the bladder. Beginning at the base of the triangular space, this substance inclines inwards as it advances towards the neck, forming in a great measure the orifice, and appearing to be continued through the urethral passage as its elastic membrane. This elastic triangular substance yields, in some measure, to the pressure of the urine, when impelled by the detrusor, and returns to its original situation when the pressure is removed. If the inflammation be situated more in the upper part of the bladder, there is danger of its extension to the peritoneum, and the pain is greater on pressure; but the desire to pass urine is not so frequent, nor the difficulty so great.

The progress of the disease depends on the severity of the symptoms. Very severe cases, occurring, for instance, after suppressed gout, sometimes terminate fatally within a short time from the commencement of the attack; but, in ordinary cases, if active measures be employed, the pain, after two or three days, begins to subside, and the water flows with greater facility, is less acid, and of lighter colour. The febrile symptoms, and, at the same time, the local uneasiness, lessen.

This kind of inflammation sometimes terminates in the formation of abscess in the coats of the bladder, of which the symptoms are of a very formidable character, depending upon the size and situation of the abscess. The abscess may open into the cavity of the bladder, and in this case, pus is evacuated with the urine, and the patient experiences great relief; or the matter may extend into the cellular tissue of the pelvis, and make its way either through the rectum, or to the perineum, or even to the groin, and in these cases the result is most frequently fatal. Mr. Wilson mentions an interesting case, in which extensive suppuration had taken place in the coats, from the prostate even to the fundus of the bladder, the matter being lodged everywhere between the coats; while near the fundus several ulcerations had penetrated the internal membrane, by which the matter had passed into the cavity of the bladder. After the formation of the abscess the urgent symptoms of the inflammation then subside; but there is a dull pain in the region of the bladder, occasional rigors with febrile excitement, and uneasiness in passing urine and fæces.

This disease may easily be mistaken for acute inflammation of the prostate. The uneasiness and pain in the region of the bladder and the perineum, the occasional but strong desire to pass urine, every effort being attended with great pain and retention, are symptoms common to both diseases. In inflammation of the prostate, however, there is more fulness and tenderness on pressure in the perineum, and on examination per rectum, the prostate is found exceedingly sensitive, painful, and swollen.

In recent cases, the morbid appearances in acute inflammation of the muscular coat are, great vascularity, the tunic being thorough injected with blood, and of dark red colour. Sometimes this coat is found even to be gangrenous ; the instances are recorded where it has given way, and urine has escaped into the pelvis. The mucous membrane is also found of a dark red colour. In other cases the membrane is thickened, and the bladder itself contracted. Pus is found sometimes infiltrated through the tunic, or else circumscribed in the form of abscess.

Acute inflammation of the bladder is sometimes caused by exposure to cold, and indulgence in spirituous liquors ; but more frequently it occurs on a sudden suppression of the discharge in gonorrhœa, when metastasis takes place to the bladder. Amongst its causes may also be classed, wounds and blows, or injuries from the incautious or violent use of instruments. The immoderate use of cantharides internally in excitable persons, even the external application of that medicine, will produce this disease. After an irregular or suppressed attack of gout, this affection comes on, and frequently assumes a very serious and formidable character.

The following case is one of the best illustrations of this form of inflammation which has come under my notice. Richard Serigiter, æt. sixty-eight, watchmaker, after a slight attack of gout, was seized with rigors, which were succeeded by fever and great constitutional irritation. The pulse was extremely quick; the skin was hot and dry; and there were great thirst and sickness. He had a strong desire coming on in paroxysms to void urine; but he could pass but a few drops at a time. There was pain in the region of the bladder and loins. —Colchicum and saline aperients, were administered; leeches and warm fomentations were applied to the region of the bladder; and the warm bath was tried. The bladder being distended, a catheter was introduced; and between two and three pints of very dark urine were drawn off. None of these measures gave relief: the constitutional disturbance increased, delirium came on, and the man died within forty-eight hours from the commencement of the attack. On the day after his disease, I examined the body, and found the bladder in a state of intense inflammation: in its structure, there was no organic change; but the tunics, particularly the muscular one, were of very deep red colour. I have the preparation of this case in my possession; and although it has been in spirit several years, it still retains its redness.

The symptoms of this disease are so severe, and its progress so rapid, that prompt and decisive measures must be adopted. If the patient be strong and robust, general blood-letting must be first employed; or, if the patient be delicate, and of spare habit, local bleeding, as leeches to the pubes, or cupping in the perineum, may be substituted; or both of these may be put in requisition as auxiliaries to general blood-letting.

Hot fomentations should be constantly applied to the pubes; and, after the bleeding, the patient should be placed in a hot bath. As already observed, there is in these cases retention; and the urine must, from time to time, be drawn off by the catheter. Internally, our main reliance must be placed on the use of calomel and opium, which must be given every three or four hours; this medicine affording the most speedy relief. As there is often tenesmus, the proportion of opium should be large; and sedative injections should, at the same time, be administered. After the urgency of the symptoms has subsided, saline aperients, combined with the vin. semin. colch., will be found beneficial, especially if the attack has occurred in a gouty subject. The diet must consist entirely of lukewarm mucilaginous drinks. If the complaint has arisen from the suppression of the discharge in gonorrhœa, it will subside on its reappearance.

If these means be employed early, the patient soon experiences a diminution of pain. Urine is passed in greater quantities and with less suffering; his constitutional symptoms improve; and he falls into sound and refreshing sleep. If, on the contrary, these measures be delayed, the symptoms before described become aggravated; and delirium and death ensue.

CHAPTER VIII.

CHRONIC INFLAMMATION OF THE MUSCULAR COAT OF THE BLADDER.

It not unfrequently happens that after an attack of acute inflammation, the bladder never recovers its usual tone, and the chronic form of the disease supervenes. At other times, chronic inflammation exists without having been preceded by the acute form of the disease; but if its history be carefully traced, it will be found that inflammatory symptoms of a sub-acute character have for a long time been going on and neglected, which, though mild at first, have been gradually becoming exasperated, until a disease which might have been perfectly tractable at its commencement, terminates in one that is extremely distressing, and seldom cured.

Chronic inflammation, or, as we now more correctly term it, hypertrophy of the muscular coat of the bladder, renders the walls of the viscus so thick that they no longer admit of their former degree of distension. In this disease, there is uneasiness about the region of the bladder, frequent desire to make water both night and day, but especially by night, and the urine does not flow so readily as usual; there is also occasional prolapsus of the rectum; and these symptoms are increased by exercise. The patient frequently complains of pains in all the limbs and in the region of the back, of a sensation of bearing down in the region of the bladder, with occasional fulness in the perineum, and a sensation of trickling in the part, of difficulty or slowness in passing urine, and of a clasping or closing effort of the bladder in the act of micturating, which is increased by the muscular exertion.

In this state, the coats of the bladder become thick and hard, so that they no longer admit of their former degree of extension. Now, it must be understood that the neck of the bladder and the urethra have around them the muscles termed the compressor prostatæ, the levator urethræ, and the ejaculator seminis, besides the columns of the levator ani. All these muscles must relax before a drop of urine can pass; and any inflammatory action in them directly obstructs the passage, whilst it hinders the contraction of the bladder itself. The contraction, indeed, of one set of these fibres, and the relaxation of the other, belong to the same act, like the condition of opposing muscles in the motions of the limbs; so that if the bladder be not in a state to execute its functions, these muscles are not in a condition to relax. "The elasticity of the neck of the bladder," says Mr. Guthrie, (*On Diseases of the Bladder, Lect. XV.*, p. 256,) "is impaired; it will not dilate with the ordinary action of the detrusor muscle; and this action is therefore augmented. A sensibly increased delay is experienced before the water begins to flow, the patient is obliged to expel it;

and he becomes conscious of the augmented effort made by the bladder. The desire in which this originates soon amounts to uneasiness, and rapidly afterwards, to pain—relieved indeed on evacuating a little water, but too soon to return ; for now the bladder is never completely emptied, and the urine which remains is a source of great irritation, although the quantity be really inconsiderable."

On dissection, the bladder will be found more or less thickened ; its inner surface presenting a considerable number of rugæ, caused by projection of the enlarged fasciculi beneath. Dr. Baillie has given the representation of a bladder nearly an inch in thickness ; the prostate gland being at the same time enlarged. One of the most ordinary changes in the bladder, from its natural structure, says that physician, is the great thickening of its muscular coat. In a natural state, the muscular coat of the bladder, when it is moderately distended, consists of thin layers of muscular fibres, running in different directions. These are probably, altogether, not more than the eighth of an inch in thickness. The muscular coat of the bladder, however, is occasionally found considerably thickened. This arises from an additional quantity of muscle being formed in consequence of extraordinary efforts being necessary in the bladder. These efforts take place when there is any considerable difficulty in making water, as happens when the prostate is a good deal enlarged, when there is a stone in the bladder, or when there are strictures in the urethra. It is usual, therefore, to find this thickening of the muscular coat, when there is any of these diseases. When the bladder is thickened, the fasciculi of which its muscular coat is composed become much larger; but they never, or at least very seldom, acquire the full red colour which muscles of the same size have in other parts of the body. This is a deviation from the general plan of nature with regard to the increase of muscles from exercise. When muscles are enlarged in size from exercise, they also become of a deep red colour. There is no instance in the body, as far as I recollect, of a muscle being so much enlarged beyond its natural size in consequence of increased exertion, as the muscular coat of the bladder. Between the fasciculi of the muscular fibres, little pouches are formed by the inner membrane of the bladder, which is impelled by the strong powers of the muscular coat. These pouches are often large enough to admit the end of the finger, and contain occasionally small calculi. The bladder in this state admits of very little distension, so that it is capable of containing little water: hence the inclination to make water is frequent, and frequent efforts of the muscular coat are required, which increase more and more its thickness. When the disease has been of long duration, and severe at the same time, the mucous lining of the bladder becomes partially or wholly abraded, exposing the hypertrophied muscular fasciculi. Mr. Guthrie thinks this a rare occurrence: from my experience, I am inclined to draw an opposite conclusion, and do not consider it so uncommon a disease. When the mucous tunic is abraded on the spot where the ureters terminate, the inflammatory action and its consequences extend up these tubes to the corresponding kidneys, and hence we not unfrequently find the pelvis of one or both of the kidneys ulcerated, as well as the interior of the bladder.

This disease, though frequently the sequel of acute inflammation, is also caused by strictures in the urethra, enlargement of the prostate, prostatic calculi, cold, stone, indulgence in spirituous liquors, by irritating medicines, as cantharides, and, in some constitutions, by the long continued use of cubebs and copaiba. In persons having an hereditary predisposition to urinary affections, as well as in gouty and rheumatic subjects, it occurs from slight causes. The retention of urine in the bladder, after the desire to void it has been felt, often brings on the disease.

When this disease is caused by stricture or any local cause, it is clear that the primary affection should especially engage our attention ; though even when that has been removed, the inflammatory disease often remains. In gouty, rheumatic, or plethoric persons, colchicum given at night, in the dose of one or two grains of the acetous extract, will be found of great service ; and as, in these cases, the urine is acid, and often scanty, the alkalies should also be given. I usually advise them to be taken after meals ; and I employ them in a combination of bicarbonate of potash, sesquicarbonate of soda, and nitrate of potash. In addition to these medicines, great benefit will be derived from pareira brava, a very useful medicine, which may be given in ten grain doses, three times a day, or in the form of decoction.

I have often, with great advantage, tried the infusion of wild carrot seeds in this form of disease; but this medicine should not be given nor persisted in, if there be any irritation of the mucous membrane.

The diosma, in the form of infusion, combined with the alkalies and tincture of hyoscyamus, will be found of great service. If the urine is not acid, or, as is not unfrequently the case, should the alkalies produce headache and restlessness, or uneasiness about the region of the stomach, their use must be discontinued, and recourse had only to sedatives, as extract of hop, and of uva ursi, or nitric ether, with tinctur. camph. comp.; and the occasional exhibition of suppositories. The diet should be plain, but nutritious; beer, wine, and spirits, should be prohibited; and exposure to wet and cold, which invariably aggravates the disease, carefully avoided.

As in these cases the bladder is by its own efforts seldom completely emptied, a catheter should be introduced from time to time, and the patient be instructed to do this for himself. Unless this direction be strictly attended to, the patient will become worse, and serious consequences ensue.

CHAPTER IX.

INFLAMMATION OF THE PERITONEAL COAT OF THE BLADDER, AND OF THE SUBJACENT CELLULAR TISSUE.

There is one other variety of acute inflammation of the bladder that demands our attention, I allude to that of its peritoneal coat, and subjacent cellular tissue. This is seldom confined to the bladder; it generally extends over the whole of the membrane, and is often the close of a fatal disease of this organ. That it takes place, however, under other circumstances, without any dangerous consequences, is sufficiently proved by old adhesions occasionally found connecting this part to the omentum, to portions of the intestine, to the uterus, or to the rectum.

On dissection, we not unfrequently find the abdominal or peritoneal coat of the bladder inflamed, as well as the mucous and muscular coats. Inflammation sometimes attacks the peritoneal covering, owing to that action spreading to it from another part of the membrane. Nevertheless, though the circumstance is rare, cases have occurred in which acute inflammation was limited to the peritoneal tunic of this organ. As a reason for limitation to this particular membrane, Dr. Baillie suggests the quantity of cellular tissue interposed between the serous and muscular coats, and the laxity of their connexion.

The pain and its aggravation on pressure, the state of the pulse, the countenance, and the position of the body, clearly indicate the nature of the disease. The same treatment which is employed in general peritonitis must be adopted in inflammation of the peritoneal covering of the bladder. The lancet, leeches, calomel and opium, and warm applications, must be vigorously employed. The disease rarely, if ever, proceeds to suppuration; but coagulated lymph is sometimes thrown out on the inflamed surface, forming adhesions with some other part of the peritoneum, where it covers other viscera, or lines the cavity of the abdomen.

The inflammation of the external covering of the bladder is, moreover, generally connected with inflammation of the adjoining lining of the pelvis. In these cases there occurs a peculiar train of symptoms, requiring a different plan of treatment from that suited to inflammation of the peritoneal coat of the bladder.

The pulse is rapid, varying from 100 to 140 in the minute. The skin is hot, the tongue dry, and the countenance anxious. The patient complains of pain and tenderness upon pressure in the hypogastric region. The abdomen next becomes tympanitic, the pulse intermits, and hiccup occurs. In many cases delirium ensues; but I have known the mind retain its clearness to the last. Rigors sometimes precede death. The morbid appearances observed are:—infiltration of serous fluid around the neck of the bladder, and, between this organ and the rectum, sloughing of the areolar tissue, discoloration of the peritoneum covering the bladder and rectum, with occasional effusion of a small quantity of lymph upon its surface. Now, this is not a case of uncomplicated peritonitis. The disease spreads from the areolar tissue to the serous membrane, and remedies directed to the removal of the morbid condition alone would prove of little avail. Abstraction of blood hastens the fatal termination; while stimulants may prolong life, if they do not save it. Sometimes the cellular tissue around the bladder is the seat of chronic disease; and abscesses may form in different parts of it, without the bladder being affected. These cases are always involved in great obscurity, and they often terminate fatally.

Dr. Elliotson (*Med. Gaz.*, vol. i. p. 130) relates the case of a female, forty-two years of age, in whom an abscess formed between the bladder and the symphysis pubis, which terminated fatally in about two months from the commencement of the disease. She complained of violent pain in the hypogastrium and over the pubes, shooting back to the loins, and frequently attended with a sensation of numbness and tingling in the right thigh, extending to the toes. The hypogastrium and pubes were very tender to the touch; there was, occasionally, a copious discharge of puriform matter from the vagina, tinged with blood; and the urine generally passed freely, but had sometimes been retained for two days together. There was much tenesmus with pain in the rectum; the tongue was white; there was no appetite, but frequent nausea; the bowels were usually opened twice a day, and the pulse was weak and small.

On examination, an abscess was found in front and deeply behind the symphysis of the pubes, extending laterally beyond the abdominal rings, so that the round ligaments passed through it. The surface of the bone was rough, blackened, and denuded of its periosteum, but not carious. The abscess contained a dark-coloured and very fœtid pus, which had free exit through the urethra, a portion of the whole circumference of which was here destroyed. The suppuration was entirely anterior to the bladder, which was rather turned to the right side, but, with the uterus and vagina, was perfectly healthy. The pelvis was large and well-proportioned.

Sometimes, however, there is found, posterior to the bladder, a pseudo-abscess, which is really seated within the cavity of the peritoneum, within the pouch of that membrane, lying between part of the posterior wall of the bladder and the rectum. The pus in these cases arises from partial peritonitis; lymph glues together some folds of the intestines, the fundus of the bladder, and the lower part of the sigmoid flexure of the colon; and into the closed sac, of which these parts thus connected form the roof, and the peritoneal pouch the floor and lateral walls, the pus is poured. The contents of this pseudo-abscess may, if small in quantity, be absorbed, and old adhesions alone remain to indicate the pre-existence of the disease. More commonly the pus finds its way into the peritoneal cavity, and death from general peritonitis follows. The inflammation on which, in these cases, the formation of pus depends, assumes a chronic character. After a short but sharp febrile attack, attended with hot skin, quick pulse, thirst, white tongue, loss of appetite, confined bowels, with pain in passing solid stools, high-coloured urine, the evacuation of which is attended with pain in the hypogastric region, and tenderness on deep pressure immediately above the pubes, the patient becomes hectic. The febrile symptoms, commonly so called, cease during the day, return with violence at night, and in the morning terminate with sweating. Sometimes it is the night fever of which the patient most complains, and sometimes it is the night sweats. He still has uneasiness in the pelvis, not, however, amounting to pain. If the case goes on to a fatal termination, the patient either dies worn out by the hectic, or he falls a victim to the peritonitis, induced, as I before observed, by the escape of the purulent fluid into the general peritoneal cavity. In the latter case the symptoms are those of perforation of the intestine, but ordinarily somewhat less violent. The treatment consists, at first, in local depletion by leeches, applied immediately above the pubes, or by cupping-glasses placed over the sacrum ; calomel and opium administered every few hours, so as gently to affect the gums ; hot fomentations, or bran poultices to the hypogastric region ; mild aperients and simple enemata ; the diet being strictly antiphlogistic.

When hectic symptoms show themselves in such cases, the treatment must be decidedly restorative. The patient must be supported with strong broths, jelly, &c. In some cases a little wine must be allowed. At the same time vegetable bitters and mineral acids will be found of considerable advantage. Quinine or decoction of bark, and dilute sulphuric acid, are the best of their class.

CHAPTER X.

MALIGNANT DISEASES OF THE BLADDER.—HARD AND SOFT CANCER—TUBERCULOSIS.

The bladder is occasionally the seat of cancer, which may commence in it as a primary disease, or spread to it from neighbouring organs, such as the uterus or rectum. Although Rokitansky describes fibrous cancer as one form which occasionally, though rarely, attacks this organ, I must say that I have never yet witnessed any true instance of the kind. I have seen cancer of the uterus and ovaries spread to the vesical walls, render them thick and nodulated, and adherent in one mass with the parts near which they were placed; but these cancerous nodules did not seem to me to resemble the true fibrous cancer, by which the natural structure of an organ, such as the mammary gland, is infiltrated and converted into a hard cartilaginous knot.

Medullary cancer has been correctly described by the same eminent pathologist, as being developed in small masses between the muscular and mucous coats. Its course is then variable; it may make its way internally through the mucous coat, and give rise to a deep ulcer with raised edges, which perforates any of the viscera in proximity; or it may protrude externally, elevating the muscular and peritoneal coats, and encroach upon the abdominal cavity. But by far the most frequent form of the disease is that described by Mr. Travers and others, as the malignant medullary fungus, which springs from the mucous membrane and the sub-mucous tissue, and projects as a mass of soft, vascular, cauliflower vegetations, which bleed upon the slightest touch.

"There is a malignant medullary fungus," says Mr. Travers, (*Med. Chir. Trans.*, vol. xviii.,) "of the mucous coat of the bladder, resembling that of the nares and uterus, breaking, bleeding, and re-produced as quickly as it is displaced. It is of very extensive attachment, and gradually reduces the cavity to very small dimensions. Portions of fungus and coagula of blood become plugged in the urethra, and form firm pellets, so as to produce retention. It is a very painful disease: it keeps the patient in constant anxiety to void urine, which is more or less tinged with blood; and frequently he passes blood alone. He dies hectic and wasted."

This disease is generally first developed in the parts about the neck of the bladder, the trigon, or the posterior surface; and cases occur in which the vegetations fill a diverticulum or sacculus of the bladder, where they constitute a tumour, which, by its pressure, may cause retention of urine.

These tumours vary much in size; some being, when solitary, as large as a goose's egg, of which Lusitanus narrates an instance (*Prax. Med.*, lib. ii., *Obs.* 71). When they are numerous, they are usually at the same time small; a remarkable case of the kind is related by Desault. (*Op. cit.*)

When we attempt to trace the cause which gives rise to these fungous formations in the bladder, we naturally inquire whether any long continued source of irritation, such as the presence of a stone, exercises an injurious influence in this respect. It is now well known that local causes will, in some cases, determine the development of cancer. I have seen many cases in which fungous growths connected with the gums and mucous membrane of the tongue or cheek, have been clearly traced to the local irritation of a decayed tooth or piece of dead bone. But yet I am not quite prepared to say that fungus of the bladder is in any way connected with the presence of a calculus. We have no satisfactory evidence upon this point. The number of patients who have for many years suffered from the irritation of a stone, without any other bad effects than those produced by chronic inflammation of the mucous membrane of the bladder, induces me to believe that the cause of these malignant vegetations is deeper-seated; and that it is to be referred to some individual peculiarity, or to some hereditary taint, which is now, by modern investigation, well known to exercise, in a most important manner, the development of the whole class of those intractable affections which are included under the head of cancer.

The symptoms accompanying this disease frequently resemble those of stone. In a case of fungus hæmatodes, which Mr. Mayo examined with the late Mr.

Wilson, and in which, from pain in the bladder and occasional discharge of blood, the existence of stone had been suspected, a fungus was found attached by a narrow pedicle to the mucous membrane; the texture of the fungus was soft, and its surface shreddy and ragged.

A discharge of blood with the urine, observes Warren, (*On Tumours*, p. 393,) is the first sign of this disease. The quantity is, at first, so small as scarcely to tinge the urine, but it gradually increases till it becomes a formidable and exhausting symptom. There is but little pain attending it ; but this symptom varies in different cases, both of fungus and scirrhus, some cases going through their course with a very moderate degree of pain. Constant desire to pass urine is one of the most distressing consequences of this affection ; and this is accompanied with sympathetic irritation of the rectum, and inclination to stool. The disease comes to a fatal issue rather from the consequent derangement of the stomach and intestines, than from pain or hæmorrhage.

In the spring of 1848, Dr. Lankester was consulted by a gentleman, æt. sixty-two, of small stature, active and temperate habits ; he had nevertheless suffered much from dyspepsia, for which he had consulted medical men, and latterly had been compelled to attend to his diet with more than ordinary care. About twelve months before Dr. Lankester saw him, he was suddenly attacked, while working in his garden, with pain in his back, followed by a desire to make water, which, when passed, he found to be discoloured with blood. He immediately sought for medical assistance, but the pain in the back continued, and there was a fresh appearance of blood in the urine. He lost flesh as well as appetite, and his nights were sleepless; the frequency of the desire to pass water increased, and the pain in the back continued, extending thence down the thighs. Under these circumstances it occurred to his medical attendants that stone in the bladder was the cause of his symptoms, and he was sounded more than once, but without any stone being found. When seen by Dr. Lankester he was very thin, with an anxious countenance, and peculiar stoop in his gait. He suffered much from dyspeptic symptoms and severe gastrodynia; the bowels were habitually constipated, and never relieved without medicine. He was restless at night, and obliged very frequently to get up and make water; there was severe pain in the back and in the region of the bladder above the pubes, where pressure caused severe suffering. The urine, passed every hour or hour and a half, was sometimes more coloured than at others. It was acid, and, after standing a considerable time, threw down a deposit, which, under the microscope, presented lithate of ammonia and organic shreds, apparently of mucus and fibrine. Blood corpuscles and pus globules could also be detected. On applying heat and nitric acid, albumen was precipitated. After a variety of treatment, he consulted an eminent surgeon, who passed a catheter, and endeavoured to inject the bladder. The operation was attended with great pain, and followed by an increased amount of blood in the urine. It was found impossible to get the fluid to pass, although the catheter was fairly beyond all possibility of prostatic obstruction. In the month of January, in the following year, he died. Upon examination, the lungs and the liver were found healthy; the heart of natural size, with slight deposits upon the mitral and semilunar valves. Both kidneys were enlarged, the left much more so than the right; the capsule was easily separated from the mass of the kidney; the tissue was soft and easily broken down, but there was no conversion of tissue. The pelvis contained some puriform fluid which was traceable down the ureter. The right kidney was the smaller; its pelvis was highly injected, and parts of its surface presented granular degeneration. The bladder was empty, and, when grasped from the outside, the coats were firm; while on opening it through the urethra, a loose organized mass of yellowish colour was found free within it. Attached to a point near the neck of the bladder, was a granulated mass highly injected, presenting portions of red colour passing into white. It was easily broken down with the knife, and yielded to slight pressure. Higher up the bladder, and on one side of the fundus, another tumour presented itself of larger size, but having the same character as that below. The mass that was loose had evidently been separated from one of the portions still in connexion with the bladder. The coats of the bladder were very much thickened; the prostate was considerably enlarged, and on cutting into it, several points presented themselves, in which was found matter of precisely similar character to that of which the growth in the bladder was composed. The spleen, stomach, pancreas, and absorbent glands of the abdomen, both in the mesentery and along the course of the great blood-vessels, were examined, but they presented no trace of malignant disease.

About the same time the following case came under my own care :—T. S. B., æt. fifty, stout, and of a gouty habit, in May, 1848, passed bloody urine for the first time, having previously had no other symptom than severe pain in the back. He continued to pass blood in the urine for five or six months, at first without pain, but afterwards with intense suffering. The blood at the commencement was fluid, and diffused in the urine, but after a short time coagula of blood were passed, and the passing of these occasioned great pain. At the end of six months the appearance of the blood almost entirely ceased, but symptoms of chronic inflammation of the bladder came on. There was frequent desire to pass urine ; great pain or scalding at the time of passing it, and afterwards the urine was loaded with stringy mucus. Some of the symptoms being those common to stone, he was sounded three or four times, but no calculus could ever be detected. The sound could scarcely be moved at all in the bladder, its motion being evidently impeded by some morbid growth, and the sounding was always attended by severe suffering. His local symptom increased in intensity ; his strength and appetite began to fail him, and in the following May he died. The only new symptom in the case was a constant dribbling of the urine for the last two or three weeks prior to his death. On examination of the body, the bladder was found occupying the greater part of the pelvis, and fixed in its position by morbid adhesions, which extended on all sides, and were very indurated. On passing the hand between the bladder and rectum, the glands along the course of the right ureter were found diseased. The right kidney itself was more than double its normal size, the other was only slightly enlarged. Both on section presented a clean surface, of an ash-grey appearance, the natural structure was obscured, and more or less destroyed by infiltration of disease. Towards that part where the bladder is usually uncovered by the peritoneum, the part seemed much softer and readily gave way. The interior of the bladder was filled to a great extent by a morbid growth of a cancerous character, which seemed to take its origin from the mucous coat, and was much enlarged towards the neck. In some parts the albuminous tissue and muscular coats were completely absorbed, in other parts they were not much affected. It has only recently been examined under the microscope, and consequently was greatly altered by spirit, but it was clearly seen to be of a most malignant character.

The existence of fungous excrescences from the internal surface of the bladder, may be ascertained during life, in some instances, by the introduction of a catheter; but, in general, we are never certain of the nature of the disease till the parts are examined after death.

There is generally noticed severe pain in the back, often commencing suddenly; frequent inclination to void urine, and an uneasy sensation, sometimes amounting to severe pain, which extends to the perineum, along the urethra to the glans, and to the pubes. This pain is generally more severe after the bladder is emptied. The patient may labour under retention of urine in consequence of the tumour pressing on the inner orifice of the urethra; and there may be a constant wearing pain in the loins, caused by the tumour having obstructed the orifices of the ureters, and produced dilatation of the kidneys. In these cases, there is always a disposition to hæmorrhage, and it is sometimes so great as to be the immediate cause of the patient's death. The urine, moreover, often contains small portions of the medullary matter.

Here we may employ the microscope as an additional means of diagnosis. In the shreds of soft structure, voided by the urethra, we find all the characteristics of cancer,—the assemblage of nucleated cells which indicate an organized, yet rapidly increasing, growth of low vitality.

All surgeons are agreed upon the difficulty of detecting morbid growths of the bladder in their early stages. Cases of simple polypus, both small, and of such size as completely to fill the vesical cavity, have occurred, which could not be distinguished during life from a tumour of a fungous or malignant nature. Pain in the loins or back may arise from disease of the kidney, as well as of the bladder. Bloody urine often ensues from hæmorrhage from the kidneys; from congestion of the mucous membrane; from ulceration connected with the presence of stone. Frequent desire to micturate comes on from disease of the urethra, prostate, bladder, or kidneys. Dr. Lankester, however, remarks with reference to hæmorrhage as a symptom, that when blood flows after the introduction of the sound, or passes in small quantities from the urethra, after the flow of urine has terminated, we may conclude that the hæmorrhage is not from the kidneys but from the bladder; and in these cases there is occasionally mixed with the blood small portions of the fungous growth. He, however, concludes, as have others, that we are without any absolute diagnostic sign of the presence of this disease.

When ulceration takes place, the nature and appearance of the matter discharged affords another diagnostic distinction.

In some cases of malignant disease of the rectum in men, and of the womb in females, the disease is communicated to the bladder; ulceration of that organ takes place; and a communication is established between the rectum and the bladder, and between this last and the vagina,—a circumstance which renders the patient's state deplorable. It is doubtful, however, whether the ulceration be of a true scirrhous character. In the paper just quoted, Mr. Travers says, "Scirrho-cancerous ulceration of the bladder I never saw; scrofulous often, particularly in children. When the bladder adheres extensively to the rectum in cancer of the latter, and when they communicate by a fistulous aperture, so that air passes by the urethra as well as feculent urine, I have not seen the coats of the bladder presenting the appearance of scirrhous cancer. The vagina and rectum in the female, on the contrary, are undistinguishably affected by the scirrhous ulcer and fungus."

By way of treatment in these cases, all we can do is to allay pain and irritation by the use of sedatives, taken internally, as well as in the form of suppositories or injections, introduced per anum.

The bleeding is sometimes so copious, as materially to exhaust the powers of the patient. In such cases, our endeavours must be directed to restrain the bleeding, while we sustain the powers of life without increasing local excitement. Astringents should be given internally; and the patient should be kept in the horizontal position. On the necessity of keeping the patient in this position too much stress cannot be laid; for, in severe hæmorrhage from the bladder, especially in old persons, syncope has come on whilst the patient has been sitting up, or exerting himself; and death has occurred. The powers of life are generally much exhausted; and the urine is often alkaline, and contains albumen, and a large proportion of the phosphates.

If, in these cases, the urine be very alkaline, the decoction of pareira brava, with nitric acid, will be very serviceable: on the contrary, if the urine becomes acid, uva ursi, with the fixed or volatile alkalies, will be the most appropriate remedy.

Tubercle is, occasionally, deposited in the bladder. I have seen it occur in two situations; first, in the mucous membrane, near the surface of the urethra; secondly, under the peritoneal coat, between it and the muscular coat, and at the fundus of the bladder. In the vesical mucous membrane tuberculous deposit produces changes similar to those which we witness in the alimentary canal. Small granular deposits lead rapidly to ulceration, and upon opening the organ after death, we find one or more circular ulcers, with sharp, well-defined edges. "Tubercle of the vesical mucous membrane," says Rokitansky, "is rare, and is not always found as a complication of tubercular affections of the urinary apparatus, which, as we have already seen, is combined with and results from tuberculosis of the sexual organs."

Tubercle on the exterior of the bladder generally indicates the presence of the disease in some neighbouring organ, especially the uterus or ovaries in the female. The accumulation of the morbid deposit may be such as to glue together the different organs, thus materially interfering with the free action of the detrusor urinæ. It is only in persons where the tubercular cachexia is very strongly developed that this disease exists in its well-marked forms.

Tuberculosis of the peritoneum may of course involve that part of the membrane which forms a covering to the bladder. The deposit is usually in small isolated masses, the membrane upon which they are placed being often spotted and dark-coloured.

"A polypus," says Dr. Baillie, "sometimes grows from the internal surface of the bladder; but this morbid appearance very rarely occurs. I have seen only one example of it; and, in that instance, it filled up the greater part of the cavity of the bladder. It was very irregular in its shape, consisting of various projecting masses, and it seemed pretty firm in its texture."

A case of this kind occurred in the practice of the late Mr. Crosse, of Norwich. A child, æt. one year and a half, was troubled with frequent inclination to make water, attended with great straining and much pain. Medicine failing to relieve, Mr. Crosse at length sounded the bladder, but felt no stone. Alkalies, opiates, and the warm bath were employed; the patient always resting better on the night when the bath was taken, although his symptoms increased in severity. He was continually wet with urine, which was passed in drops, an effort being made, with violent straining, at various intervals, from a few minutes to half an hour. The nights were passed in the same manner as the days, except that during the former, the little patient was said to scream more and strain rather less violently; unless laudanum were given to him he never got any rest till the morning, when he would occasionally sleep for an hour or two. At almost every attempt to pass urine fæces were passed, but the rectum never prolapsed. About every two or three weeks, Mr. Crosse used the sound gently, and twice thought he felt a stone, but not satisfactorily; the impression was conveyed on passing the sound towards the left side of the bladder. No bleeding had followed the different soundings performed during three months, and the urine was generally voided more easily afterwards, and sometimes as much as a table-spoonful at a time.

Dec. 28. Mr. Crosse again used the sound, which was resisted by something unusual towards the left side of the bladder; for several days after this examination the urine was tinged with blood. The patient had become greatly emaciated by this time, the skin hanging flabbily about him, and the countenance presenting as expressive a picture of suffering and grief as could be witnessed. Soon afterwards another opinion was taken, but the evidence respecting the existence of a stone was unsatisfactory. Various ideas passed through Mr. Crosse's mind ; he thought that a stone might be encysted at the termination of the left ureter, as it was thereabouts that the resistance was always felt. While sounding, he had frequently introduced the finger into the rectum without gaining any information, except that when the child screamed, and the muscular coat of the bladder contracted upon its contents, the organ felt as a firm tense ball, about twice the size of a walnut.

The little boy was evidently sinking under his painful disease ; and when two years old it was determined that an operation should be attempted for his relief. Mr. Crosse introduced the curved staff without difficulty ; the anus prolapsed from violent straining. The surgeon who assisted at the operation stated his opinion that he felt a stone ; Mr. Crosse, on the other hand, could only feel a resisting body at the left side of the bladder about the termination of the left ureter. After a few minutes delay it was determined to cut into the bladder. The staff having been withdrawn during the consultation, it was re-introduced, and held in a proper position, when Mr. Crosse observed a great fulness of the perineum. As soon as he had cut down to the staff, and opened the membranous portion of the urethra, a semi-transparent substance appeared in the wound, resembling the mucus which had been passed from the rectum by the child's straining when first placed upon the table, and Mr. Crosse feared he had, for the first time in his life, wounded the rectum, an impression which momentarily invaded the minds of the by-standers. With the assistance of the left forefinger, guided by the staff, he carried the scalpel forward to the neck of the bladder, and on withdrawing the knife, he observed that the wound became instantly filled with a mass resembling what one would have expected to see had the peritoneum been opened, and the vermiform process, and several folds of small intestines protruded. The protruded parts were pushed back; and on carrying the left little finger into the bladder, Mr. Crosse felt no stone, but found the cavity filled with soft tumours, and with a firmer substance near the orifice of the left ureter.

" If I betrayed," says the operator, " any judgment in this case, it was undoubtedly in this stage of the business by relinquishing the forceps held in readiness for me, and in withdrawing my finger from the bladder." The same parts then protruded, and they proved on inspection to be tumours, connected together like a cluster of grapes, some more, some less transparent; resembling in firmness, appearance, and structure, the mild polypus nasi; the membrane by which they were connected with each other, and with the inner surface of the bladder, was long and loose enough to allow some of the tumours to hang externally dependent at the wound: they had entered the urethra by the violent straining of the child, when first placed upon the table. The nature of these tumours being now understood—namely, that they were mild polypous masses, growing from the inner surface of the bladder, it became obvious, that the only chance for the patient's recovery must be sought by removing them. All that were in sight were cut off with the scissars, but the violent straining efforts, which the child had kept up during the operation, brought several more tumours, as big as grapes, sufficiently low down to admit of their being cut off. Upon introducing the forefinger into the bladder, Mr. Crosse ascertained that more of the diseased structure remained behind than had been removed; and as many of the remaining tumours were attached to the bladder by a broad basis, it was deemed advisable to make no further attempts for their removal.

Notwithstanding the administration of a powerful opiate, the child continued to have violent fits of tenesmus, and could scarcely be prevented from placing himself in his usual posture, resting upon his knees and elbows, to give full effect to his exertions. At the end of four hours, Mr. Crosse placed him again upon the table to ascertain whether these efforts had caused any fresh tumours to protrude. The wound was plugged up with a coagulum, under which was a tumour as big as a nut, and of purple colour; this was easily brought down and cut away with scissars. Much of the diseased structure remained which could not be meddled with safely. After forty-four hours of incessant suffering the little patient died.

Examination of the body.—The peritoneum was free from signs of inflammation; the rectum was untouched; the ureters were much enlarged and contorted; the pelvis of each kidney so increased in size, that between one and two ounces of urine could be contained in it. The muscular coat of the bladder was much thickened; at its fundus there was a convex prominence, covered by peritoneum, which, when cut into, proved to be a firm mass of thickened cellular substance, situated external to the muscular coat, and containing a small central cavity filled with pus. The lining or mucous membrane of the bladder, of gelatinous appearance, but loosely connected, and in folds, gave origin to the disease. From the interior part near the neck numerous tumours sprung, occupying the cavity of the bladder; one, of large size with broad basis, of firmer consistence than the rest, was situated near the termination of the left ureter; this must have been the resisting body felt on sounding. Several small detached tumours, from the size of a pea to that of a bean, were loose in the bladder: towards the neck the tumours presented a wart-like surface: but all were covered with their proper membrane continuous with the inner coat of the bladder, which was uninjured, except in three or four spots, where the tumours had been cut off with scissars.

The neck of the bladder and the prostatic portion of the urethra were much dilated, and the tumours could readily drop into this part of the canal, a fact which accounts for the fulness of the perineum.

Cases of polypus vesicæ have been recorded also by Collison, Petet, and Covillard. Mr. Warner (*Philos. Trans.*) relates the case of a tumour growing from the inside of the bladder: he extirpated it successfully.

CHAPTER XI.

ABNORMITIES OF THE BLADDER.

Abnormities of the bladder may be either congenital or acquired. The former are always dependent upon some irregularities in the law of fœtal development, by which the cavity of the bladder is generally left incomplete, the opening being either in front, through the abdominal walls, or behind, communicating with the rectum. The former is the more common, and the only congenital deficiency with which I am acquainted.

A good account of this abnormity has been given by Mr. Holmes Coote in the *Medical Times.* We are there informed that the germs of the embryo arrange themselves into three layers,—the serous, the vascular, and the mucous. The serous corresponds with the posterior surface of the body, the mucous with the anterior, and the vascular layer constitutes an intermediate structure whence arise the earliest arterial and venous tubes. The serous layer is reflected backwards, the two borders uniting posteriorly to form a canal, which becomes the vertebral column and the cranium; it contains an assemblage of corpuscles, which arrange themselves in linear series to form the brain and spinal chord. The anterior, or mucous layer, curving round, forms a large anterior canal, also filled with these corpuscles of development; it becomes subsequently divided into those compartments along the front of the body which we recognise as the mouth, the chest, and the abdomen. If at any period of fœtal life, the formation of these great canals and the completion of the viscera they contain is for a time arrested, the further growth but imperfectly remedies the deficiency; there is something wanting, which in many instances proves of serious inconvenience to the individual through life, and in others is the cause of death soon after birth. Anencephalous monstrosities and spina bifida are familiar examples of arrest of development in the serous layer; and hare-lip, and deficiences of the bony or the soft palate, of similar arrest in the mucous layer. The sternum is sometimes divided into two vertical pieces, between which the pulsation of the heart, the swelling of the lungs, and the distension of the great veins, are exposed to the eye. The lower part of the abdomen is more rarely open; when it is, the front wall of the bladder is then also incomplete, and the urine escapes through the wide aperture. This occurrence appears to be more common in males than females. Isidore G. H. Hilaire says, that of known and recorded examples when he wrote, a fourth only were females; and Mr. Earle found on searching the records of instances of this congenital defect, that eight had been observed in the female, and sixty in the male. Mr. M'Whinnie states, in an interesting paper in the *Medical Gazette*, that out of nine cases which have fallen under his observation, two only were females. There may be fissures in other of the abdominal viscera co-existent with this defect; in the female there is usually absence of the anterior commissure of the labia and the clitoris, and in the male fissure of the urethra on the dorsal surface of the penis or epispadias.

Some of the cases admit of relief by surgical operation, as the different varieties of hare-lip; others do not much interfere with the patient's comfort, as for example, the fissured sternum; but the abnormity to which I now propose to call attention, fissure of the anterior part of the bladder and of the abdominal walls, produces, by the escape of urine over the person, great suffering and annoyance, which by the proper adaptation of instruments may be alleviated.

A patient thus imperfectly formed, presents at the lower part of the abdomen a soft, red, vascular swelling, formed by the protrusion of the posterior wall of the bladder. The penis, in a case related by Mr. Erichsen, was rudimentary, with complete epispadias; the urine, constantly distilled from the open mouth of the ureters at the lower part of the swelling, and fell during the erect posture, in part upon the open groove of the urethra which served imperfectly as a spout. In each groin was a projection which became more marked as the growth of the body advanced, corresponding with the widely separated pubic bones. From the want of the symphysis, and consequent support in front of the pelvis, there resulted considerable weakness in the part, and much awkwardness in motion. These inconveniences, as well as the general deformity, were further increased by the distance to which the thighs were thrown apart from one another. This case is particularly interesting from the fact that an account of the post-mortem examination has been published by Mr. M'Whinnie in the *Medical Gazette,* the patient having died of phthisis. "In the groin," he observes, "on each side of the malformed genito-urinary organs, is seen the prominence corresponding with the body of the pubes. The general aspect of the body, as well as the signs manifested during life, showed that the period of puberty had not been retarded. Here there was no appearance of umbilical cicatrix; the recti abdominis, in the upper two-thirds of their extent, were about an inch apart; below this a triangular space was left by the divergence of each muscle to the corresponding pubic bone, which was separated from its fellow to the distance of about two inches and a half. Through this fissure the irregular nodulated mucous surface of the posterior wall of the bladder protruded; its muscular fasciculi had acquired considerable strength. The mouths of the ureters, directed towards each other, were surrounded by prominent papillæ. On looking into the pelvis, the vacuity there was very striking; the space between the anterior wall of the abdomen and the rectum, ordinarily filled by the bladder, being here entirely unoccupied.

"At the upper margin of the vesical tumour, the obliterated umbilical arteries converged to come into contact with the remains of the umbilical vein, which took a longer course than usual to reach the liver.

"The pubic bones, often connected by strong ligaments in cases where they are disjoined, which in some measure counterbalances the want of osseous union, had merely a few thin fibrous bands passing between them, quite inadequate to give fixity to the parts, or to support the viscera.

" The rudimentary penis measured about one inch and a half in length ; the glands, cleft at the upper part, had appended to it below an imperfect preputial covering. The epispadias was complete ; the urethra presenting a simple open groove or furrow, upon the surface of which several follicles opened. The prostate, deficient above, was of tolerable size beneath the canal. Into this part of the urethra the seminal ducts terminated as usual on each side of the verumontanum.

" The testes though diminutive, were, as in most analogous cases, natural in structure. They had descended into a small contracted scrotum. The vasa deferentia had their proper relation to the vesiculæ seminales, which were below the natural size. The ureters, sometimes so enormously dilated as if designed almost to compensate for the want of the proper reservoir, were quite natural. Each corpus cavernosum diverged from its fellow ; and taking a more transverse direction than usual, was connected by its crus with the corresponding ischium, where it was covered by a few faint fibres of an erector muscle. Some slender elongated fibres occupied the situation of the transversus perinei. As in many other instances, the anus was immediately behind the scrotum."

This imperfection in the lower part of the abdomen, arrest of development in the "hæmal arch" of Professor Owen, may be confined to the want of union of the pubic bones, the bladder being entire. Cases of this description have been described by Mr. Mayo, of Winchester, and M. Vrolik. The subject, recorded by the former, was a woman who suffered from urinary calculus and died of disease of the kidneys. In the case mentioned by the latter, there was denudation of the anterior surface of the bladder, and partial division of the penis, the imperfect closure extending thence along the front wall of the abdomen.

The imperfection may involve the viscera as in the instance of extroversio vesicæ before related. It is clear that in these cases there can be neither allantois nor urachus. The open bladder often extends somewhat higher in the abdomen than natural, and seems to involve some of that fœtal prolongation which becomes in after life the imperforate and fibrous urachus. Rokitansky remarks, that in these cases we find in the hypogastrium, immediately beneath the navel, which is always placed very low, a red mucous dilated spot, the edges of which coalesce with the common integument. In the male sex it passes downwards so as to terminate in the fissure of the urethra. In the female it is surrounded with two diverging tumours which represent the labia, and it terminates in the lamina of the general integument which invests the rima vulvæ. The ureters open upon this mucous surface, and their orifice is generally found at the inferior half.

Mr. Lloyd, of St. Bartholomew's Hospital, in a case which recently came under his care, proposed to establish by means of a seton a fistulous communication between the bladder and the rectum. This canal being completed, he intended to close the fissure in the abdominal walls by paring the edges and bringing them together by needles and ligatures. Owing, however, to irregularity in the extent to which the peritoneum descended along the posterior wall of the bladder, the perforating instrument introduced behind the prostate gland, opened the serous cavity. Acute inflammation ensued, and the patient died a few days after, labouring under the usual symptoms of peritonitis. In St. Thomas's Hospital, a successful operation by which the ureters were made to open into the rectum, was performed upon a boy by Mr. Simon. Instruments were introduced armed with threads, from the ureters into the rectum ; these threads were there retained until the passages became permanently established. Serious constitutional disturbance ensued, but the patient struggled through, and was eventually able to bear the pressure of a pad in front, by means of which the opening in the abdomen was closed and all the urine forced into the rectum.

We cannot, however, conceal from ourselves that these operations, undertaken solely to relieve a patient from inconvenience and deformity, are extremely hazardous to life ; and perhaps it may be a question whether other evils, equally severe, might not arise from the permanent irritation caused by the presence of acrid urine upon the mucous membrane of the rectum, and by its mixing with the fæces.

Mr. Wiblin, of Southampton, has recorded, in the *Medical Times,* an interesting case of this deformity, illustrated by a drawing exhibiting the appearance presented upon the front surface of the abdomen. The patient, twenty-eight years of age, of robust and masculine appearance, was employed as a coal-lifter on the quay. At a very early period of his life he had been examined by several medical men, who conveyed to his relations the impression that he was an hermaphrodite ; and under this appellation he has passed the latter years of his life, subjected to the most painful annoyances. His dress consisted of a very long smock frock, but in consequence of the great inconveniences occasioned by the dress being sometimes found frozen to his person, this attire was abandoned for high leggings. The pubic bones are separated to the extent of at least three or four inches, and a distinct cartilaginous band passes across from one angle of the pubic symphysis to that of the other, and in a measure tends to compensate for the weakened condition of the parts which such a separation must necessarily produce. The rudimentary penis is about one inch and a-half in length, and has a perfectly formed corona glandis ; the prepuce is bifid, and has the appearance of two wart-like appendages. Upon the upper surface of the organ is a groove, in which are seen numerous lacunæ, and at its base is observed the termination of the ejaculatory ducts, on either side of the caput galli vaginis. Through the extensive triangular opening in the inferior parietes of the abdomen the posterior wall of the bladder protrudes. When the patient assumes the erect posture the swelling is about the size of a very large orange. The mucous membrane of the upper portion of the tumour is highly vascular and shining. On the inferior and lateral portions of the protrusion there is an exceedingly sensitive and painful strawberry-like pulpy surface, and below this on either side, are the external openings of the ureters, from which the urine is observed to dribble away as fast as it becomes secreted. Above the parts thus described, and immediately under the apex of the triangle formed by the separation of the abdominal parietes, is a small hernial protrusion. In this case, as in those recorded by the late Mr. Earle and Mr. M'Whinnie, there is no umbilicus. The groins are generally the seat of extensive ulceration, produced by the irritating properties of the urine.

It is not long since Mr. Wakley, of the Royal Free Hospital, exhibited to the London Medical Society a patient the subject of malformed genito-urinary organs. "The society," observed Mr. Wakley, "will remark that no umbilicus exists; the abdominal muscles are separated at their lower part, through which appears the posterior wall of the bladder with its muscular and mucous coats, very painful to the touch, and readily bleeding. The orifices of the ureters can be distinctly seen; the urine is constantly dribbling from them, and flows over the rudimentary penis, producing very severe excoriation of the part. The rudimentary sexual organ is about one inch in length, and closely applied to the inferior part of the tumour, which, when depressed, displays complete epispadias, the urethra being merely a groove. The opening of the seminal ducts can be seen at the root of this rudimentary penis; and upon each side is a prominence corresponding with the partially descended testes. The parts are partially covered with hair; and every symptom of manhood existed to the discomfort of the patient." In this case the pubic bones were in apposition and firmly united. Mr. Wakley proposed to perform an operation for the purpose of protecting the painful and highly vascular urinary tumour, by transplanting a covering from the neighbouring integuments of the abdomen. Two flaps of skin were to be dissected from the integument in immediate contact with the lateral edges of the tumour, leaving a broad root still attached to the skin immediately over it. These portions of skin were then to be twisted over a silver shield, modelled so as to cover the tumour without pressing on it. As union progressed, the silver shield was to be lowered and diminished in size until only an opening should be left for the passage of the urine at the root of the newly-formed bladder. Incontinence of urine, Mr. Wakley thought, would then be the only discomfort the patient would experience.

There may exist a fissure of the bladder in the opposite direction; it is then accompanied by fissure of the rectum, and the formation of a common cloaca.

That constricted part of the common fœtal vesical cavity between the allantois and the true urinary bladder, termed the urachus, sometimes remains patent from the bladder for a short distance, or through its entire length. In a case of this kind, the patient, upon attempting to expel the urine, finds some of the fluid escape by the umbilicus. The integuments in front of the abdomen are somewhat excoriated; the umbilicus is red, and presents at one spot a prominent red papilla or elevation, in the centre of which is an opening through which there was always a discharge of pus or mucus, and occasionally during the day, of urine. A probe passes readily downwards in the direction of the bladder. Various measures to obtain closure of the tube were tried without success. Mr. Paget, of Leicester, has recorded in the transactions of the Royal Medical and Chirurgical Society, the case of a man, forty years of age, in whom a ring-shaped calculus, formed upon a hair in the bladder, was extracted through a patent urachus at the umbilicus. The bladder being distended, Mr. Paget introduced the finger through the duct and removed the calculus without trouble. In this case it was obvious that the bladder and the urachus formed one urinary receptacle, which in shape might be compared to a curved neck cupping-glass.

Cases occasionally occur in which an abscess forms in the umbilical region; and when it has been opened a quantity of pus and urine escaped. Perhaps in these cases there has been partial closure of the urachus; then the urine has been, by some violent expulsive effort, forced along the canal, which has reopened and permitted its escape into the areolar tissue of the navel. The canal remains permanently open.

Complete deficiency of the bladder we hear sometimes spoken of. It must be accompanied with imperfect development of the kidneys, absence of the urethra, and defective development of other organs. The ureters, if they exist and are pervious, open into the navel or into the common opening of the vulva.

These abnormal conditions of the urinary bladder do not admit of relief by surgical operation. Relief, however, may be afforded by the application of instruments to retain the urine within the vesical cavity, and to prevent the excoriation of the integument.

In extroversio vesicæ, when there exists fissure, both of the abdominal walls and of the exterior surface of the bladder, an apparatus recommended by the late Mr. Earle, and described by Mr. M'Whinnie in the *Midical Gazette,* may be worn with great advantage and relief. It consists of a silver bowl, covering and protecting the tumour and external organs, and retained by a double truss or appropriate bandage in situ. The collected urine flows through a funnel at its lower part, into an Indian-rubber bottle placed between the thighs.

When the urachus remains open, a light truss, with a pad of proper size, may be constructed to pass round the body and press upon the umbilical opening. The patient from whom Mr. Paget extracted the calculus wore a girdle with a thick flannel pad to catch the jets of urine which were apt to occur when he was at work. Mr. Startin has found that great advantage may be derived to the surrounding excoriated parts by varnishing them with collodion.

I may here speak of an abnormal condition of the bladder, which though not hereditary but acquired, often demands the attention of the surgeon. It is the "sacculated bladder"—"cellules vesicales." In consequence of some obstruction in the urethra to the flow of the urine, the muscular coat of the bladder becomes highly developed, the fibres of the inner layer especially, presenting a reticulated appearance. No longer forming an even plane, these muscular bands become grouped together, and project in the form of elevated decussating bars. The mucous membrane, insinuating itself into the interspaces, yields to the pressure when the bladder contracts, and becomes by degrees forced outwards so as to form a pouch or bag.

These sacs are for the most part free and unattached except at the base ; but occasionally they contract adhesions with surrounding parts. Civiale has in his possession a bladder almost entirely covered with these, so as to resemble a bunch of grapes. Platner saw one having thirty-nine sacs, each one containing a calculus. I have seen others of a similar character. The sacs are sometimes large, sometimes small, and as Civiale remarks, the volume is almost always in an inverse ratio to their number. But Heister met with a bladder in which there were three large sacs, one on the right, another on the left, and a third at the summit, independently of very many others which were being developed in different points of the organ. They generally contain urine, sometimes a mixture of pus and mucus, sometimes a calculus. Tuberculous matter may be deposited in them ; or they may give origin to a fungous growth of malignant character. These last two conditions are rare. In most instances it is on the posterior surface of the organ, or towards the fundus, that these sacs form ; and on examining the preparations preserved in anatomical museums, we find the neck and anterior part of the bladder rarely so affected.

Mr. Solly related the following case of sacculated bladder at the Pathological Society :—A man, æt. fifty-one, was admitted into St. Thomas's Hospital, April 22, 1851, with retention of urine. He had suffered from stricture for three years. The stricture generally became worse, and at last ended in complete retention, for which he had been admitted, under Mr.

South, in January. He stated that he had never had a catheter passed before this, but that he had several times experienced a discharge of blood with urine. On this occasion all attempts to introduce a catheter into the cavity of the bladder failed; the instrument, though passing far enough to reach that organ, not moving freely, and no urine coming away through it. The retention, however, was relieved, and the urine, at first thick and alkaline, was rendered clear by the administration of dilute sulphuric acid. He went out, passing his urine in a very good stream, the latter end of February. Soon, however, the stream lessened, and for ten days previous to admission the urine only dribbled away. Several ineffectual attempts had been made to introduce the catheter, which caused profuse hæmorrhage.

On admission, a large sized catheter was introduced sufficiently far to reach the bladder, but no urine followed. On examination per rectum, the prostate was found of natural size. Next morning, Mr. Solly succeeded in introducing a full sized catheter, and drew off a quantity of thick, very offensive urine, apparently containing a good deal of pus. There remained an irregular lobulated tumour in the left hypogastrium, apparently solid, painful, and tender on pressure.

On the 27th, he complained of severe pain in the tumour; he had passed a considerable quantity of urine so that it was thought needless to introduce a catheter. The countenance became anxious, the tongue furred, and the pulse quick and weak. The urine was dark-coloured, very thick, extremely offensive, and showed, under the microscope, many crystals of phosphate of lime, a few blood corpuscles, and a quantity of granular matter aggregated in irregular masses. Next day he became comatose, and died the following morning.

Upon examination after death, a stricture was found about the membranous portion of the urethra ; there were also several false passages. There was no disease or enlargement of the prostate. The muscular coat of the bladder was very much thickened, and in several places large herniæ of the mucous coat had escaped between its fibres, and formed capacious cysts, communicating by narrow orifices with the cavity of the bladder, which were full of urine. It was these cysts which had formed the tumour in the left hypogastrium, which had been noticed during life. Both ureters were very much distended throughout, and at intervals swelled into large cysts. The mucous coat of the bladder was very much thickened, inflamed, and ulcerated. Both kidneys were larger than usual and pale.

The presence of these sacs gives rise to serious symptoms. The urine in them cannot be expelled, owing to the absence of a muscular covering, and the orifice may be small by the formation of a morbid band or valve. The urine may deposit gravel, become fœtid, and, according to Chopart, give rise to abscess between the walls of the organ. Calculi may drop into them, and be formed in them. If the sac be large and distended with urine, it may excite many of the symptoms of retention ; and the lining membrane may undergo a process of softening and disorganization attended with general disturbance of the constitution. The introduction of a catheter into the bladder affords but imperfect relief. The distended sac presses against the neighbouring viscera, generally the rectum, and may be felt through the abdominal parietes, especially in thin subjects, as a hard tumour. It might be necessary to puncture the sac from the rectum to relieve the patient from the distressing symptoms that are thus occasioned. It sometimes happens that the catheter, having drawn off the contents of the bladder, finds it way into one of these sacs ; immediately a large flow of urine, capable of being expelled with greater force by pressure, with the hands upon the anterior surface of the abdomen, but not by any muscular effort, indicates the nature of the occurrence. Great care must be taken lest the point of the instrument perforate the thin vesical parietes.

CHAPTER XII.

WOUNDS AND INJURIES OF THE BLADDER.

Rupture of the bladder generally occurs when the organ is full from a sudden blow, or from the pressure of a heavy weight upon the lower part of the abdomen. It has ensued from the passing of a carriage wheel over the hypogastric region; from a man running against a beam or post; or from injury received in wrestling or boxing. The symptoms of this serious accident are not always immediately manifested. Patients have been known to walk a considerable distance before any suspicion was entertained of the real nature of the injury which has been received. The following case was related at the Medical Society of London, by Mr. Hird:—A bricklayer, after drinking with some friends at Kensington, was knocked down and run over by a cab, he was taken to the house of a surgeon in Lambeth, who dressed a slight wound on the head. After this he walked home to Pimlico, a distance of nearly two miles, and about three hours after, at the request of the gentleman who ran over him, Mr. Hird saw him. He found him in bed, and complaining of severe pain in the hypogastric region ; but having drunk to excess the patient was unable to give an account of his sensations at the time of the accident. He had vomited two or three times, and had felt great desire to make water ; but not more than two or three table-spoonfuls, slightly tinged with blood, had dribbled away. He was cold, had occasionally shivered, and was covered with a clammy perspiration. The pulse was full, and 120. The abdomen was distended, but did not evince, on examination, the circumscribed form observable in cases of distended bladder from retention. The patient died three days afterwards. On opening the abdomen the bladder was found small and contracted, with an oblique fissure, an inch and a half long, in the posterior inferior part, and opening into the peritoneal cavity. The mucous membrane of the bladder was healthy and slightly everted at the aperture.

Rupture of the bladder generally occurs in that part of the organ covered by peritoneum ; it is there that the walls yield least readily to distension. Yet cases are upon record in which the rupture was in the anterior wall of the bladder immediately behind the pubes.

In the "Transactions of the Pathological Society," Mr. Prescott Hewett has related ten cases of ruptured bladder. "In two of these ten cases there was no injury of the bones ; in eight the pelvis was extensively fractured. In two cases the bladder was ruptured into the peritoneum (one being with fracture of the pelvis, the other without). In eight cases the rupture was into the cellular tissue of the pelvis ; in these eight cases the bladder was ruptured in its fore-part in five, in its lateral parts in two, at its neck in one.

"Both the cases into the peritoneum were most interesting: the one from its rarity, the injury having occurred in a woman, of which there are very few cases indeed placed on record; the other from there being so small a quantity of fluid found in the peritoneum, merely an ounce, and yet the rent in the bladder was large enough to admit of the passage of the two first fingers, as well as there being no trace of inflammatory action about the serous membrane.

"The variety of points at which urine extravasated into the subperitoneal cellular tissue might show itself, was also well illustrated in some of these cases. In one, the patient living twenty-three days, large abscesses made their appearance above the pubes and in both iliac fossæ. In another, in addition to these regions, the scrotum and perineum became extensively infiltrated. In a third, the right side of the scrotum was the part principally affected, the urine having passed through the right internal ring and down the inguinal canal. In a fourth, the upper part of both thighs was affected, the urine having passed through the obturator foramina.

"Lastly, the reparative efforts sometimes made by nature in accidents of this kind were also well shown. In a patient who lived five days after the accident, the cellular tissue in the immediate neighbourhood was condensed by lymph, forming a species of pouch connected with the margins of the rupture. In another case, living twenty-three days after the injury, the surrounding cellular tissue was so condensed, and so firmly attached to the margins of the rupture, except at a small point, that the secondary cavity thus formed presented the appearance of a sacculus of the bladder which had given way. With regard to the point where the lymph was detached, Mr. Hewett thought this appearance was due to the tearing off of the false membrane during some efforts made by the patient : the history of the case, he considered, showed this. An aggravation of symptoms suddenly takes place, and the urine, which for several days had been passed without inconvenience or effort, now makes its appearance in the incision in the iliac fossa, and henceforth flows freely through this opening."

A wound of the urinary bladder uncomplicated with injury to the peritoneum or extravasation of urine into the cellular tissue, such as one made by the trochar in puncturing the bladder above the pubes, is not very dangerous. I do not concur with Chelius in the opinion that when the wound is at the upper part of the bladder, the urine ought to be carried off by the introduction of a piece of partially unravelled linen introduced between its lips. It is the better practice to trust to a catheter introduced by the urethra, and retained in the bladder by a proper bandage.

Patients have recovered from gunshot wounds both of the bladder and rectum. The following case is related by Mr. South in his translation of Chelius's Surgery :—Col. A., while in action before Alexandria, March 20, 1801, received a grape shot through the right ischiatic notch, which taking a circuitous route, passed through the pelvis without wounding any large vessel or nerve, came out under Pouparts ligament on the left side, and was found in his pubic bone. In its passage the ball had wounded both the rectum and bladder. The colonel was removed from the "Desert" on board the "Trusty" under the care of Mr. Este, who found him sinking very fast. He, however, constantly applied poultices as hot as could be borne, and gave him bark, camphor, ammonia, &c, with brandy and bottled porter, by which latter he was much refreshed. The physician-general and others were called in consultation, and agreed that recovery was impossible. The wound being gangrenous, discharged extremely, and was intolerably offensive. The fæces and urine passed through the lower wound, but there was no natural evacuation by the rectum or urethra.

After some days a favourable change commenced; the sloughs separated, healthy pus was produced, and at length the wounds healed, the fæces and urine passing by their natural channels. When able to use crutches, Col. A. was sent to Malta. Stricture ensued, of which he was ultimately cured by Sir A. Cooper.

A patient, the subject of such an accident, is weak and faint, with feeble pulse, cold extremities, and anxious countenance. He is often sick, and prefers lying with his knees drawn up and his shoulders raised. He suffers severe pain in the hypogastric region, the abdomen is full, but there is no trace of the rounded outline of the distended bladder. He is unable to expel the urine, and sometimes loses all desire to make the attempt. The little urine that escapes, or is drawn off by the catheter, is tinged with blood. In relation to diagnosis, it is to be observed, that although the bladder has been ruptured, there is sometimes a circumscribed tumour in the hypogastric region.

In fractures of the bones of the pelvis, the bladder is often injured, either by the force of the concussion, or by a spiculum of the fractured bone penetrating the coats of the bladder.

I have known the bladder to be ruptured by a fall from the top of a coach. A gentleman was riding on the box, with his coachman, when the carriage was upset, the coachman fell on him, and by this accident the bladder was ruptured. The patient lived from the Sunday on which it occurred till the following Wednesday.

I am indebted to Dr. Peacock for the following interesting case :— A horse-breaker, aged thirty-eight, while driving a restive horse in a gig, was thrown out, and the vehicle passed over the lower part of his abdomen. He was immediately carried to the Chester Infirmary ; no marks of injury were displayed externally, and after rallying from the effects of the fall, he seemed pretty well. The following afternoon, however, it was ascertained that he had not made water since the occurrence of the accident, and the catheter being introduced, about eight ounces of fluid, deeply tinged with blood, were withdrawn. He then also began to experience considerable pain in the hypogastric region, and there was much tenderness on pressure, for which he was bled and leeched. The catheter was required to be introduced at intervals for several days, after which he regained the power of voiding water, the urine assumed its natural appearance, and the febrile symptoms, to a considerable extent, subsided. He, however, declined in strength, typhoid symptoms came on, and he sank on the 16th of January, 1841, or on the seventeenth day from the receipt of the injury ;

two days before death he again had retention of urine, and the fluid removed by the catheter was very dark coloured and fœtid.

The body was examined twenty-four hours after death. No fluid was contained in the peritoneal cavity. The omentum was firmly attached by old adhesions, to the abdominal parietes in front, and to the intestines below. The small intestines were also firmly united together, and had become adherent to the edges of the pelvic cavity. The bladder displayed, at the posterior part of the fundus, a lacerated opening capable of admitting of the passage of two fingers, which led into a cavity situated posteriorly and inferiorly to it, and which was bounded by the adherent intestines above, by the sides of the pelvic cavity laterally, and by the rectum behind and below. The cavity contained fœtid urine, mixed with shreds of lymph and gangrenous cellular tissue. On the side where it was bounded by the rectum there was an ulcerated aperture, by which it had opened into the rectum. This aperture was nearly the size of half-a-crown, and was situated at about four inches from the verge of the anus. The adhesions by which the omentum and intestines were united together and to the edges of the pelvic cavity, were evidently of old date, and long anterior to the accident. The coats of the bladder were much thickened, and its lining membrane was covered with tough mucus mixed with lymph. The kidneys were much enlarged; they were easily deprived of the proper tunic, and the surface exposed was of a deep purple colour. Their texture was infiltrated with small purulent deposits, and the organs were generally very soft and readily tearable.

The prolongation of life in this case was evidently due to the peculiar situation of the laceration of the bladder, in consequence of which the urine had escaped into the vesico-rectal cellular tissue. The extension of inflammation to the peritoneum had also been prevented by the old adhesions of the omentum and intestines in the hypogastric region.

The following is the explanation offered by Dr. Harrison of the fact, why, when the bladder is ruptured by a blow or general concussion, the laceration is generally found in that part of the organ which is covered by the serous membrane. The several tunics of the bladder allow of considerable distension, but least of all the peritoneal: when, therefore, the bladder becomes fully distended, and is subjected to any sudden or violent compressing force, this tunic, which is then tense, and comparatively unyielding, will crack, while the subjacent tunics which are connected to it will be torn along with it; whereas, in other situations where cellular tissue occupies the place of the serous membrane, the coats of the bladder will yield considerably before they give way or admit of laceration. (See *Dub. Jour. of Medical Science*, vol. ix. p. 371.) The bladder being pressed forcibly against the promontory of the sacrum in the male, has been stated to account for the rent being usually in the posterior region of that viscus.

The rarity of the accident in females is ascribed by Dr. Harrison to the greater size of the pelvis, the cavity of which is not so extensively occupied by the bladder when this is full of urine. Nor (says he) does the bladder incline so much backwards as in the male; on the contrary, it inclines more forwards, and enlarges more in the transverse direction; while the uterus and its lateral broad folds may assist to break the shock of any external violence applied to the hypogastric region, and so prevent the direct concussion of the bladder against the sacral promontory. (*Dub. Jour. of Med. Science*, vol. ix.; and *Cooper's Surgical Dictionary*, 6th ed., p. 266.) The comparative infrequency of a rupture of the bladder in children and boys, is referred, by Dr. Harrison, to their rarely suffering the bladder to become much distended with urine; and also, in part, to the smaller size of the sacral promontory, and to the bladder, when full, lying in early life more in the abdomen.

When excessively distended, the bladder may give way. A case of this kind is mentioned by Sir E. Home, (*On Strictures*, vol. ii., p. 241,) and another by Dr. Johnstone. (*Memoirs of the Medical Society*, vol. iii.) In such cases, the urine escapes into the cavity of the pelvis; and all that we can do, is to introduce a catheter, and leave it in the bladder, in order to limit, as much as possible, the quantity of urine effused.

These cases almost always terminate fatally. On examination, the cellular tissue of the pelvis is found in an inflamed, or rather sloughing state; near the fundus of the bladder there are one or more small pin-like holes, with black and ragged edges; while the viscus is found relaxed and empty, and the abdomen full of urine. It is not properly a rupture which then takes place, but a yielding or giving way like that which occurs after ulceration in the urethra, and lays the groundwork of fistula. Owing to excessive distension, ulceration takes place; the coats of the bladder are weakened; and the urine bursts through them.

After typhus fever, instances of sloughing of the coats of the bladder occasionally occur; an irregular opening with ragged edges being, after death, generally found in the posterior part of the organ through which the urine has escaped. In such a case there must have been great neglect on the part of the attendants in allowing the completely paralysed bladder to become distended. It is a good plan for the surgeon, if called in upon these occasions, to assure himself of the condition of the bladder by putting his hand upon the hypogastric region; while he should also always inquire what quantity of urine has been voided during the preceding twenty-four hours. The introduction of the catheter is of course easy, and the instrument should be regularly used night and morning.

When the posterior part of the bladder is ruptured, and the surgeon is certain of the exact seat of injury, it has been proposed to make an incision along the upper surface of the rectum corresponding to the rupture, and thus give vent to the extravasated fluid per anum.

In cases of labour, the bladder has been known to burst; and most practitioners concur in thinking that such an accident must always be the effect either of neglect or of improper interference.

In a case of this kind, related by Mr. Hey in the fourth volume of "Medical Observations and Inquiries," the bad symptoms attendant on retention of the urine did not take place till the second day. The patient who was thirsty, and vomited, had frequent desire to void urine, which she did very suddenly, but not in greater quantity than a tea-spoonful at a time. The pulse was quick, the belly swelled, and pressure gave her pain. She died about the eighth day, and the bladder was found to be ruptured at its upper part. A case is also related by Mr. Bedingfield, in which the bladder seems to have burst during a very easy labour of only two hours' duration. The patient died of peritoneal inflammation. (*Lancet*, June, 1837.)

One cause of laceration of the bladder may be the use of instruments in labour during a distended state of that organ. If the forceps be applied while the bladder is full, the action of the instrument is likely to produce laceration. This event is known by the immediate and continued flow of urine through the opening. In consequence of great pressure from the head of the child, destruction of a portion of the vagina and bladder may take place,—an occurrence attended with most distressing symptoms. The urine dribbles away as fast as it is secreted, and excoriates the neighbouring parts. The protruded mucous surface of the bladder is then very sensitive, and the vagina is frequently contracted in size by firm bands, extending across it in various directions. With all these local symptoms, the patient's general health is but little affected.

The difficulty of closing an opening through which urine is constantly passing, deterred surgeons, until late years, from attempting other than a palliative treatment. Mr. Barnes, of Exeter, employs an elongated caoutchouc bottle, which, when placed in the vagina, presents an opening corresponding to the fistula. This opening is occupied by a piece of sponge, through which the urine filters into the bottle. The patient herself removes the bottle and empties it three or four times a day. (*Med.-Chirurgical Transactions,* vol. vi.) For the same purpose sponge has been employed in a case which resisted all attemps to effect a cure. (*Transactions of the Provincial Medical and Surgical Association,* vol. i., p. 542.)

The cure of the disease by ligature was first contemplated by Mr. Preston, and the operation has been performed successfully by Mr. Leeke, Mr. Gosset, the late Mr. H. Earle, and other surgeons. Two cures are also recorded in the second volume of the "Dublin Medical Journal," and one by Mr. Hobart, of Cork, in the "London Medical and Physical Journal," for 1825.

The chief difficulty attending these cases is, the continual flow of urine from the ureters. The narrow space is often rendered still smaller by preternatural contractions, and firmly cicatrized bands. Then the unresisting, elastic, exquisitely sensitive surface, cannot be readily seized by any instrument however sharp. Even when these difficulties are surmounted, says Mr. Earle, by perseverance, and a modification of the various instruments, such is the influence over the pelvic viscera exerted, by the slightest movements of the viscera of the abdomen, and by the action of the abdominal muscles and the diaphragm, that the adaptation of the denuded surface is often frustrated, and the sutures even forcibly torn away, by a single effort to cough or sneeze. When the opening is not situated between the urethra and ureters, or in the neighbourhood of the latter tubes, when it is not of great magnitude, and when there is not much hernia of the bladder, we may attempt to remove the callous edges, and unite them by the assistance of sutures. We shall be much facilitated in this operation by previously dilating the urethra sufficiently to admit the forefinger of the left hand; by which we shall be enabled to draw down the bladder, and to afford a support and resistance in removing the edges. The instruments best adapted for this purpose are very narrow double-edged scalpels, or lancets, with which we may pierce through the membranes, and cut our way outwards. These should cut only to a short distance from the extremity.

I do not agree in the statement that it is better not to attempt too much in any one operation for fear of being altogether foiled. In many instances the edges brought together by sutures have united in the course of a day or two either completely or to such an extent as to relieve the patient in great part of her distressing symptoms. Porte-aiguilles and a variety of instruments have been invented for carrying the needle a considerable distance when the fissure is situated high up in the vagina. When it is low down no great difficulty is experienced in the operation. The following is the mode recommended by Mr. Earle:—An armed needle should be fixed at the angle most convenient for piercing the denuded edges of the wound, which should be directed by the finger, and carried through the two edges. The point should be received by the other porte-aiguille, and the slide pushed up to fix it. The slide of the first should then be drawn down, which will leave the needle in the grasp of the second, by which it may be drawn through with its thread attached. To effect this in so narrow a space as the vagina, is often most difficult, and requires much patience and dexterity. The ligature should be drawn tight, and the ends cut off. Short hare-lip pins, and the twisted suture, are sometimes employed; but these are still more difficult to pass, and they cause much more irritation. In those cases, where, from the situation of the opening, or its magnitude, no curative means can be attempted surgically, a well-adapted truss, with an elastic gum pad, will often enable the patient to retain a considerable quantity of water, and to enjoy comparative comfort.

Mr. Coley has published a case in which he cured a vesico-vaginal fistula by ligature. In this instance, in lieu of a female catheter, there was used during the operation a wooden sound, one-third of an inch in diameter, on which the edges of the fissure were divided. The forceps used are supplied with a moveable ring, by means of which the needle may be retained at any angle with the greatest firmness, until the surgeon wishes to liberate it, which he can do by moving the ring towards the joint. The length of the instrument is eight inches and a half, and a drawing of it is given in the *Lancet*, 1838-9, p. 86.

Mr. Beaumont has suggested an ingenious instrument to be used in operating for this complaint; it is in the form of forceps, one blade of which is a needle curved towards its point, and close to the point is the eye of the needle. The other blade is broader on its opposing surface, less curved, and at its extremity has a hole, through which the needle-point, and just the loop of the ligature, are carried when the blades are closed. On the back of the broad blade is a spring, which, when pushed forwards, the blades being previously closed, catches the ligature on its point, and holds it at the extremity of the blade.

In using this instrument the operator has only to seize in its points, as he would with a pair of forceps, the border of the fistulous opening ; the blades should then be closed, and the ligature will be carried through one lip of the aperture. The opposite border is then in like manner to be seized, and the blades to be again closed and firmly held so. The spring on the back of the broad blade is now to be pushed forwards, by which the ligature will be caught and held at its point. The blades after this are to be opened and gently withdrawn, leaving a double ligature passed through opposite points of the fistulous aperture. Two or more stitches may be made in the same manner, leaving in each a double ligature, so that the quilled or other suture may be afterwards formed.

The following operation, called "Anaplasis," has been proposed by Velpeau, and performed by Jobert :—

A suitable bivalve speculum having been introduced into the vagina, and the fistula thus clearly brought into view, the edges are to be cut off, and three points of suture introduced. Retraction of the lips of the fissure united by the above means is obviated by dissecting off a portion of the mucous membrane of the neck of the womb, that part being previously drawn down by means of a hook. The chief feature in this operation is the so-called *décollement* of the neck of the womb. A peculiar *porte-aiguille* is employed for inserting the sutures.

Success has been said to have followed the proceeding ; but I believe some doubts are entertained regarding the ultimate condition of the patient. The edges of the fistula are first pared with a bistoury ; then a fleshy layer cut from the labia, or from the nates, is placed between them, and maintained in proper apposition until the surfaces have become united. Sutures are intróduced for this purpose by means of a catheter passed into the bladder. M. Jobert divides the pellicle which connects the folds to the structure from which it is cut, on the thirtieth or fortieth day after the operation.

Dupuytren (*Journal Hebdom.*, No. 58,) extolled the actual cautery, except in those instances in which there was much loss of substance, and some interesting cases where the cautery was used, are related in the second volume of the "Dublin Medical Journal," by Dr. Kennedy. Its application is extremely simple, and attended with inconsiderable pain to the patient. Delpech also advocated the employment of the actual cautery ; and Velpeau, though giving a general preference to the nitrate of silver, stills thinks that in a case of long standing, with loss of substance and callous edges, the actual cautery will be best as acting more rapidly and with greater energy. Delpech recommends that the vaginal surface only should be touched with the hot iron, in order to prevent loss of substance from extensive eschars. After the first cauterization, if the solution of continuity has contracted perceptibly in all directions a second application should be made, and renewed until the opening is entirely closed. It should be observed that sufficient time must be allowed for contraction to take place. Contraction, after the application of the actual cautery, goes on sometimes for months. Delpech treated successfully, in this way, a case of vesico-vaginal fistula, in which the aperture occupied the bottom of the bladder.

The cauterizing-iron should be small, round, or olive-headed, and should be applied cautiously, and but for an instant, as it will be much better to do little at once than too much. But whatever be the caustic employed, it should always be remembered that the great obstacle to the adhesion of the edges of the fistulous aperture, is the contact of the urine ; and therefore the utmost care must be taken to keep the bladder empty, by placing a catheter with large eyes, as in Desault's plan, or by drawing off the water very frequently, so as to divert it entirely from passing by the vagina. (*Cyclop. Pract. Surgery, Art. Vesico-vaginal Fistula,* Part XI. p. 233, by *W. P. Costello, M.D.*)

A case is related by Dr. Payan, in the "London and Edinburgh Monthly Medical Journal," for January, 1842, in which a cure was effected by the actual cautery, its application being repeated several times, at intervals of two, three, or six months, until the opening was all but closed.

When the accident happens from laceration, without loss of substance, it has been stated to be cured by a catheter constantly retained in the urethra, with a bladder attached to its lower end, provided the treatment is commenced soon after delivery. By this contrivance Mr. Gaitskell effected a cure in a few weeks; (*Blundell's Lectures, Lancet*, No. 222, p. 333;) but I cannot say from my own experience, that I have ever known a case of spontaneous cure when the communication is once established. The constant passage of the urine constitutes a serious obstacle to its ever closing without surgical interference; and when a case comes before me in which there exists a simple fissure, I always recommend the performance of the operation of paring the edges and uniting them by some kind of suture, as soon as possible, before the parts have become accustomed to their altered state; before, too, the edges of the fissure have grown hard and callous. The chance of success is, under these circumstances, far better than when months have been allowed to pass in attempts which always proved unavailing.

For my own part, I am convinced that with the assistance of chloroform, the anæsthetic properties of which place the patient in a condition of insensibility which materially aids the surgeon in the performance of this tedious and difficult operation, many patients may be cured of a calamity which otherwise renders life insupportable. No suffering is too severe, no peril too great, for a woman anxious again to be placed in a condition of health and comfort. The existence of a vesico-vaginal, or a recto-vaginal fistula, renders life miserable. In the former, the vagina, the labia, and the thighs, are excoriated from being constantly bathed in urine, the clothes are ever wet;

fresh urine flows with every change of posture ; and the odour is most offensive. In the latter, fæcal matter is constantly entering the vagina, especially when the motions are fluid, and the patient is always in a state of the greatest discomfort.

CHAPTER XIII.

HERNIA OF THE BLADDER.

Herniæ of the bladder are uncommon. Yet this organ, lying immediately behind the abdominal walls, capable of great distension, and influenced by pressure from surrounding structures, may be protruded wholly or in part through the inguinal ring; through the crural ring into the perineum and vagina, or, according to some authorities, into the obturator foramen. The symptoms indicating this displacement, are difficulty in making water or complete retention ; sudden escape of a large quantity of urine upon introducing a gum elastic catheter ; discharge of mucus from the urethra ; enlargement of the hernial swelling after the urine has been retained ; and the escape of urine from the urethra upon pressure of the tumour.

It has been known to occur on both sides in the same subject, and sometimes combined with the descent of a portion of the intestine. In the male it descends into the scrotum ; and a case is related by Ruysch, in which the patient was obliged to raise the scrotum with his hands, and press it, in order to make water. A second case is related by Beaumont, where the scrotum contained the whole urinary bladder in which a large calculus was lodged.

It is difficult to assign any good cause for the occurrence of a hernia vesicæ. There must, however, exist some peculiarity, either congenital or acquired, in the abdominal walls, or in the shape and size of the bladder, which brings it nearer than natural to the opening whence it protrudes. The accident is so uncommon that it is usually very briefly dismissed in surgical works. Mr. Lawrence has given the fullest account of it in his "Treatise on Ruptures," and to this source I am mainly indebted for the following information on the subject. Zerdier relates a case where the bladder and urachus, with the umbilical artery, were drawn down into the scrotum. An instance of protrusion of the organ through a wound caused by a bullock's horn is related by Larrey; and Merriman records a case in which a distended bladder, pushed before the head of the child in labour, was actually opened under the idea that it was an hydrocephalus.

An interesting fact in connexion with this displacement is the frequent existence of calculi in the protruded bladder. In a case related by Hartmann, a pudendal cystocele contained a stone weighing three ounces.

Hernia of the bladder occurs chiefly among the old ; but Pott saw it in a boy of thirteen years of age.

In a case, of which the history and dissection are described by Mr. Clement, the entire bladder had passed through the inguinal canal into the scrotum, where it had become enlarged by distension, so as to form a tumour of enormous magnitude. The patient, a very corpulent man, about sixty years of age, had been troubled with the swelling for about twenty-five years. It was small at first, and slowly increased to its immense size, having varied but little during the greater part of that time. The patient could not make water without first raising the rupture towards the belly, and then rolling it about for a short time, when the urine would pass in a full stream, though he was unable to make much at one time. He had repeatedly suffered from constipation and slight attacks of hemiplegia; but his health had been good in other respects, and he had been accustomed to take regular and, occasionally, laborious exercise. The swelling had produced no alarming or dangerous symptoms until about a fortnight before death, when obstinate constipation came on, with paralysis of the left side. To these affections was joined stillicidium urinæ, for which the catheter was used several times; but not more than a teacupful of urine was drawn off on each occasion. Although purgatives and enemata produced no relief of the bowels, the symptoms were rather referable to retention of urine, than to constipation. The pain and other symptoms increased, and delirium and death supervened. The true nature of the hernial tumour does not seem to have been suspected during life. The circumference of the swelling was twenty-nine inches; its length fourteen inches and three quarters. The whole penis was retracted within the integuments, and the urine had been discharged through an opening resembling the navel. One of the testicles could be distinctly felt at the middle of the tumour; but the other was not discoverable before the parts were dissected. Although the rupture was so large as to extend generally over the pubes, and occupy both inguinal regions, the protruded parts obviously came through the left abdominal ring. When the inguinal canal had been exposed and opened, a portion of the colon was seen traversing it, distended with fæces, but not inflamed, nor compressed, as the entire hand could be passed through the opening. On continuing the dissection, and after removing the testicle, the tumour was found to consist of a sac, resembling an enormous hydrocele, from which two quarts of fœtid urine escaped by the rupture of a part which had become red and pointed before death. It was now found out that the urinary bladder had passed through the abdominal ring, so as to form the immense scrotal tumour already described.

The part undergoes further changes after it has passed through the ring. It becomes contracted in the opening, and expands again below. Mr. Keate "found it contracted at the ring, dilating itself again in the abdomen and pelvis, and forming a kind of double bag, divided by the ring." And the same change had occurred, to a still greater extent, in an instance operated on by Mr. Pott. He discovered a membranous bag, growing narrower as it proceeded upwards; and a membranous duct, about the size of a large wheat-straw, was continued from its upper end through the ring. The urine flowing through this, when it was divided, proved the case to be a hernia of the bladder. Stones have been contained in the protruded portion in many instances.

It is necessary to the occurrence of a cystocele, that the bladder should be placed immediately behind or very close to the ring, and that it should hold that situation when empty; for the distended condition of the organ is obviously so very unfavourable to a protrusion, that it can hardly be deemed possible in that state. Repeated distension of the bag from any cause, must therefore be regarded as particularly disposing to this kind of rupture, and the lateral extension of the viscus in pregnancy facilitates its occurrence. We often discover the bladder, on dissection, adhering in such cases to the back surface of the abdominal muscles, instead of having its fundus behind the pubes.

The pouch of peritoneum, which forms the first appearance of a hernial sac, is partly formed in these cases by that portion of the urinary bladder covered by serous membrane. Into this pouch a portion of intestine or of omentum may descend, which is completely surrounded by peritoneum, the bladder being attached to the surrounding parts by cellular tissue. It is necessary to remember in operating, that the muscular coat of the bladder is very soon exposed.

In the female the enlargement of the uterus causes displacement of the bladder downwards, towards the perineum or in the vagina. Mery found in a woman, six months gone in pregnancy, a tumour, the size of a large egg, between the vulva and the anus, but a little to one side, soft and yielding, which, on compression, disappeared, accompanied with a desire to pass urine.

The descent of the bladder into the vagina is not a rare occurrence. Peyer examined the body of a woman who had long suffered from prolapsus of the uterus ; the bladder was comprised in the tumour, and the vagina was everted. Numerous other cases of a similar nature are quoted, in some of which calculi were found in the bladder.

As a cystocele may give rise to a protrusion of omentum, so an enterocele or epiplocele may cause a descent of the bladder. The symptoms of the latter occurrence have not been observed in many instances until long after the patients had been incommoded by an intestinal or omental hernia, and it has even been suggested that the former is always preceded by the latter affection, but this is contrary to experience, which has shown us that a protrusion of the bladder may exist alone.

The manner in which an ordinary omental or intestinal rupture may become complicated by the addition of a cystocele, can be easily understood when we consider that the peritoneum forming the sac is placed immediately behind the ring, and continued over the fundus of the bladder. If the original hernia be neglected, its increase elongates the hernial sac, gradually drawing into the ring that portion of the peritoneum which is attached to the bladder, and the bladder itself, if it be disposed to yield to this force. Thus a portion of the organ becomes situated behind the cavity of the first rupture, and it passes through the ring just as the fixed portion of the large intestines do in the gradual increase of a common scrotal rupture. The anatomical description is the same in this as in the preceding case. The protruded portion of the bladder is here interposed between the original hernia and the spermatic chord. The posterior surface of the sac, at its upper part at least, consists of the peritoneum covering the fundus and back of the bladder, and the proportion of the bag formed in this way depends on the extent of the protrusion.

A bubonocele taking place through the abdominal canal gradually brings the upper opening behind the lower one, so that we can conceive the possibility of the bladder being drawn through the ring in the subsequent increase of the swelling. But the relative positions of the opening, and the bladder, render the occurrence of cystocele more probable as a consequence of the internal inguinal rupture.

The symptoms of cystocele will be different, according as the protruded portion is full or empty ; confined to the groin or continued into the scrotum ; and simple, or combined with intestinal or omental rupture. When the part is empty, its volume is not considerable, the sides collapse, and examination discovers nothing but a soft membranous substance rolling under the fingers. The swelling is sometimes round and uniform, sometimes elongated and irregular ; when compressed, it causes the desire to make water, and sometimes the involuntary flow of urine ; and it increases and diminishes in size according as the bladder is full or empty. There is also a constant pain in the region of the kidneys and perineum. But the most characteristic circumstance is the state of the urinary evacuation. When there is frequent desire to expel the urine, with occasional retention ; when the tumour increases after retaining the water for some time, and is diminished, or entirely disappears on voiding the urine, the case must be a cystocele. The patient sometimes feels unable to expel the urine, without elevating and compressing the tumour, but he can accomplish it easily by that means. After voiding all that he can, a further desire to make water is excited by pressing the swelling. When the bladder has descended into the scrotum, and is full of urine, it might be mistaken for hydrocele. The dysury, the power of diminishing the swelling by pressure, and the desire of making water consequent on this, sufficiently distinguish the case. To the peculiar symptoms of cystocele will be added those of an intestinal or omental rupture, when the affection is complicated.

In some cases the protrusion of the bladder has been attended with no symptoms. Its existence was not known till after death in Mr. Keate's case, where the greater part of the viscus had passed into the scrotum ; and the same observation may be made concerning a case related by Arnaud.

Surgical treatment can avail little in hernia of the bladder. The part cannot be replaced, and we must, therefore, be contented to support the tumour by means of a suspensory bandage. If its existence was discovered in an early stage, perhaps it might be reduced by the constant pressure of a truss with a hollow pad. It seems to be hardly susceptible of strangulation ; but if such a circumstance should occur, the operation must be resorted to, as in other cases of hernia. If a stone was discovered in it, we ought to remove it by an incision. No ill consequence followed in two instances, where openings were made in the protruded portion of the bladder. (*Acad. de Chir.*, tom. ii. pp. 11, 13.)

Hernia of the bladder, under the crural arch, is very rare; one case is mentioned in the Memoir of Verdier.

The protrusion of the organ in a perineal or vaginal rupture will be indicated by the peculiar symptoms connected with the urinary evacuation. Its treatment does not differ from that of other ruptures in the same situations.

Hernia of the bladder occurs most frequently in males; but Verdier observes that pregnant women are rather liable to the affection, because, during gestation, it depends on a change in the figure of the bladder produced by the development of the uterus, which, depositing its weight on the superior part of the bladder when it is full, depresses it in that direction and causes it to extend laterally, and being in that state placed much higher than the crural arches, it has a tendency to escape through the inguinal ring.

When the bladder descends a great way, so as to form a tumour between the thighs, the only effectual mode of relieving the disease is by introducing something into the vagina; an egg-shaped pessary, or even one of the round pessaries, adapted to the capacity of the dilated parts, ascertained by a trial of instruments of different diameters. If the bladder has not descended, so as to make its appearance externally, a pessary may not be necessary; and in married women especially, it is desirable that this instrument should not be used. When the descent is beginning in this manner, it should be our principal indication to keep the bladder empty, and to tell the patient to abstain from all urging, a rule to be observed with the utmost strictness, as the infraction of it must increase the descent. Lotions of alum, of sulphate of zinc, of sulphate of copper, of galls, and so on, are recommended of various strength, according to the effect produced; and if a patient becomes pregnant, I should recommend as before, that she should be confined to the horizontal position for a few weeks after delivery, in order to allow of the vagina contracting itself, and giving the bladder a more effectual support.

The bladder is occasionally divided into two cavities. Dr. Baillie remarks :—"I have not had an opportunity myself of examining this singular disease, but I have received an account of such a case from Dr. Ash, which had many years ago fallen under his observation. The upper chamber of the bladder in this case was generally much distended with urine, so that a round tumour could be easily distinguished by the touch above the pubes. When a catheter was introduced into the bladder, a few ounces only of urine came away, and the tumour above the pubes remained as before. When the patient stood up, a quart of water sometimes passed away involuntarily, the tumour very much subsided, and the complaint was relieved for the time. After the death of the patient, the bladder upon examination was found to be divided into two chambers by a strong membranous substance, and the aperture of communication was almost obliterated."

There seems to me to be only two ways in which a division of the bladder into two chambers can happen. One is by a morbid growth of the inner membrane, forming a ridge at some particular part, and at length, by a continuation of this process, making a septum more or less complete in the bladder. I have seen the cavity of the œsophagus very much narrowed at one part by a permanent ridge being formed in its inner membrane. Something of the same kind I have also seen in a part of the small intestines. We may therefore readily admit the possibility of a similar process taking place in the inner membrane of the bladder. Another way in which the bladder may be supposed capable of being divided into two chambers, is by a very strong contraction of its transverse muscular fibres at some particular part. This will be analogous to the hour-glass contraction of the uterus, which is known occasionally to take place. When a complaint of the bladder depending upon its being divided into two chambers has been temporary, it is reasonable to suppose that it has arisen from the last cause ; when it has been permanent, it is more likely to have arisen from the first.

When two chambers are just beginning to be formed in the bladder, very little inconvenience is probably felt, because the communication between them at this time is very large. Under such circumstances, it seems hardly possible to detect the nature of the disease in the living body ; but when the disease has made a considerable progress, and the communication between the two chambers has become very narrow, it may be ascertained, or at least conjectured about with great probability, from the following circumstances.—There will then be a considerable circumscribed tumour above the pubes in the situation of the bladder when distended ; much less urine will be made than the natural quantity, and the tumour will not be sensibly lessened by it; or if a catheter be introduced, little urine will be evacuated, and the tumour above the pubes will still remain the same. But it will occasionally happen, by some particular attitude of the body, that the urine will pass from the upper chamber of the bladder into the lower, and from this it will be evacuated by the urethra: under such circumstances there will be a much larger quantity of urine made than usual, the tumour above the pubes will disappear, and the patient will receive immediate relief, which will continue till there is another accumulation of urine. I can well imagine this condition of the bladder rendering a patient disposed to hernia of the organ.

CHAPTER XIV

THE CHEMISTRY OF URINARY CONCRETIONS.

The knowledge of urinary concretions in early times was very limited. Pliny, indeed, enumerates many remedies for stone and gravel; but these are commonly of a very ineffectual character. Paracelsus conceived that urinary concretions possessed an analogy with the tartar which urine deposits. He taught that a saline spirit unites with an earthy principle which is always present in the fluids of the body, and that by this union tartar or calculus is produced. Though Paracelsus in many respects was in advance of his age, especially on points of chemistry, he certainly added little, by these speculations, to the knowledge before possessed of urinary calculi. Van Helmont made the important observation, deduced from experiments, that urinary concretions are essentially different from stony bodies. He added, that such concretions are not derived from matter contained in the food and drink. He revived an experiment made some centuries before by Raymond Lully, viz. the mixing what was then called spirit of urine, namely, solution of carbonate of ammonia, with rectified spirit of wine, by which a white precipitate was obtained. This white precipitate was termed the offa Helmontiana, and plainly is the carbonate of ammonia thrown down owing to its insolubility in spirit. After this period juster views began to be entertained as to the nature of urinary concretions. Hales confirmed what Van Helmont had taught as to the great difference between common stones and urinary concretions, by showing how large a quantity of air the latter gave off under the action of heat. He directed his attention to discovering a universal solvent of these concretions, in which, however, he necessarily failed. Subsequently Boyle, Whytt, Alston, and Slare, engaged in the investigation of this subject. Whytt proposed lime-water as a remedy in calculous disorders. Alston showed that though lime-water is, to a certain extent, a remedy, yet that it is not a solvent of these concretions. The tendency of the urine to concrete, so as to encase foreign bodies accidentally introduced into the urinary passages was fully investigated, and numerous histories of this character, in both sexes, are enumerated throughout the last century. Pretty early in the same century correct views of the nature of the urinary concretions began to be entertained in the Leyden school. It was taught that the nuclei of such concretions are derived from the kidney, or from the bladder. Van Swieten taught that the rudiments of calculi exist in the urine of the most healthy; that such concretions form by the concurrence of like elements; that if the urine be thrown forth before the tendency to this concurrence of elements takes place, that there is no concretion; that this tendency is exerted more or less slowly in different individuals, and that under this view the first concretion may take place either in the kidney or in the bladder; finally, that there is no ground of fear unless when there is a too rapid tendency to the concretion of the elements of calculi within the urinary passages. Van Swieten pronounced those fortunate whose urine shows no such tendency to rapid deposit after being passed, and congratulates himself on being in the number.

In 1776, Scheele, as before mentioned, discovered uric acid. All the calculi that he examined contained this substance. He described it as a peculiar substance, possessed of acid properties; soluble with effervescence in nitric acid, the solution affording a pink colour when evaporated, without too much heat, to dryness. This substance was first termed lithic acid, and afterwards uric acid. Scheele found all urine to contain uric acid, thus confirming what Van Swieten had remarked as to the presence of the element of calculi in urine. Soon after, Bergman discovered lime in certain calculi. After this time little advance was made till Wollaston published his treatise in 1797. In his paper three calculi are described, besides that which Scheele discovered, namely, the fusible, the mulberry, and the bone-earth calculi. The mulberry calculus had been known to surgeons for some time, owing to its peculiarity of appearance. Smithson Tennant had remarked that the fusible calculus was not consumed by heat like those examined by Scheele and Bergman; he found that this calculus passed into an opaque glass before the blowpipe; he conjectured that it contained phosphate of lime along with other salts. Wollaston showed that this calculus contained ammonio-phosphate of magnesia. He showed besides, that oxalate of lime is contained in the mulberry calculus, and also that the smaller calculi, termed hemp-seed calculi, contain the same substance. He also taught that the bone-earth calculus contains phosphate of lime, differing, however, from the phosphate of lime of the bones. A few years after, Fourcroy and Vanquelin made an important contribution to the chemistry of urinary calculi, though in their treatise no mention whatever is made of what Wollaston had discovered and taught. These chemists announced the presence of urate of ammonia and silica in urinary concretions. In 1810 Wollaston made known his discovery of cystic oxide as a urinary concretion. In 1817, Dr. Marcet published his valuable work on urinary concretions; and, lastly, in 1821, Dr. Prout by his treatise much extended exact views on this subject.

Urinary calculi being more or less regularly deposited around a nucleus, usually affect the globular or ovoid form after remaining long in the bladder, but this is by no means universal, especially in the case of renal concretions, which are often very irregular, moulded to the pelvis of the kidney, and even branched like a coralline, while those found in the ureter are cylindrical. Even the vesical calculi often affect shapes widely different from the globular or ovoid. Many of them, especially when two or more exist at the same time in the bladder, have several flattened surfaces, produced by mutual attrition, which give them a polyhedral aspect. In other cases the globe or ovoid is compressed laterally, and changed to the amygdaloid shape, and in cases in which a portion of the calculus is embraced by a fold of the mucous membrane or sacculated, the exposed part continues to increase in bulk by successive deposits, so that ultimately the sacculated portion forms a sort of pedicle to the entire calculus.

The character of the surface is as variable as the form; it may be either smooth, and even polished; covered with minute crystals; or more or less rough and tuberculated, as in the mulberry calculus.

The colours of calculi vary from white through pale yellow to brown, brownish-green, and even almost to black. Phosphatic calculi are often white; those of uric acid vary from yellow to brown; those of xanthic oxide have a cinnamon brown tint; while calculi of oxalate of lime vary from yellow to yellowish-brown, brownish-green, or even blackish-green.

The size and weight of calculi is even more uncertain. They ordinarily vary from a few grains to several ounces. Simon quotes Morand as having in his possession a calculus of the incredible weight of six pounds three ounces, Lister one weighing fifty-one ounces, and Earle one of forty-four ounces, the latter measuring sixteen inches in circumference.

The number of calculi existing at the same time in the bladder is subject to equal variation. More frequently the calculus is solitary, but it is by no means uncommon to find two or more. Murat records, what I am fain to believe fabulous, that he found 678 calculi in the bladder, and nearly 10,000 in the kidneys of an aged patient! It is also stated that no less than fifty-nine calculi were discovered in the bladder of the celebrated naturalist Buffon.

The internal structure discoverable on section is either uniform or formed of concentric laminæ encircling the nucleus. In many calculi, in addition to the concentric laminæ, lines radiating from the centre are observed, as if the laminæ were composed of perpendicular crystalline fibres. In some calculi the concentric laminæ are easily separable, in others firmly adherent. In the latter case the laminæ are sometimes, as in the oxalate of lime calculus, only indicated by faint concentric lines.

The chemical composition of the nucleus and concentric coats may be either homogeneous, or the nucleus may differ from the superimposed strata, or these again may be severally composed of different constituents, as in the alternating calculus, so that each concentric lamina must be subjected to a separate analysis.

The chemical constituents of calculi may be conveniently divided into two classes, the first containing those which sometimes form entire calculi in a nearly pure state; the second those which may be viewed as adventitious constituents, some of which are problematical.

A.—Forming Entire Calculi or laminæ.

1. Uric Acid.
2. Uric or Xanthic Oxide.
3. Urate of Ammonia.
4. Cystic Oxide, or Cystine.
5. Ammoniaco-Magnesian Phosphate.
6. Oxalate of Lime.

7. Phosphate of Lime.
8. Carbonate of Lime.
9. Mixed Phosphate of Lime, and Phosphate of Magnesia and Ammonia.

B.—Existing in small quantities associated with the preceding.

10. Urate of Potass.
11. ——— Soda.
12. ——— Lime.
13. ——— Magnesia.
14. Organic matter, fat, extractive albumen, vesical mucus, blood.
15. Carbonate of Magnesia.
16. Silica.
17. Oxide of Iron (?)
18. Benzoate of Ammonia (?)
19. Oxalate of Ammonia (?)
20. Phosphate of Iron (?)
21. Hydrochlorate of Ammonia (?)
22. Urea (?)
23. Clay Mica (??)

The following table (p. 273) drawn up by an eminent pathological chemist, Dr. Bence Jones, and copied, with some modifications, from a recent Lecture, (*Medical Times*, Oct. 1851,) affords at a glance, the mode of distinguishing the chemical composition of the principal species. The first proceeding in the examination of a calculus is exposure to a red heat, either by means of the blowpipe, or by placing a fragment of the calculus on a slip of platinum foil, and heating it in the flame of a spirit-lamp. The calculi formed of organic matter including those of uric acid, urate of ammonia, cystine, xanthic oxide, and fibrine, swell, turn black, burn, and leave but a very small residue of ash;

whereas those consisting chiefly of inorganic matter, as the carbonate of lime, oxalate of lime, phosphate of lime, ammoniaco-magnesian phosphate, and the fusible calculus, are somewhat browned, evolving more or less odour of animal matter, which burns off and leaves a large residue, often retaining the primitive form of the fragment.

If another fragment of a calculus of the first class be treated with nitric acid, the solution cautiously evaporated to dryness, and a blood-red colour be produced, the calculus consists either of uric acid or of urate of ammonia ; if the former, no odour of ammonia will be evolved by heating another fragment in liquor potassæ, or in a solution of carbonate of potass ; if the latter, the odour of ammonia is very perceptible, and a white cloud will be produced, when a rod moistened with nitric or hydrochloric acid is held over the liquids.

If no red colour be produced by the treatment of a combustible calculus with nitric acid in the manner already described, it consists of either cystine, xanthic oxide, or fibrine. If of cystic oxide, it readily dissolves in liquor ammoniæ, and crystals in the form of hexahedral plates or prisms are left after the spontaneous evaporation of the solution ; if xanthic oxide, it dissolves in liquor ammoniæ, but yields no crystals after evaporation of the solution ; it dissolves in nitric acid without effervescence, and leaves a lemon-yellow residue ; if formed of fibrine, it dissolves with difficulty in ammonia, yields no crystals by evaporation, and becomes yellow when heated with nitric acid.

If the calculus belongs to the second divison, and be not destructible by heat, it is either carbonate, oxalate, or phosphate of lime, or ammoniaco-magnesian phosphate; or the fusible calculus, a mixture of phosphate of lime and ammoniaco-magnesian phosphate. If it dissolves in hydrochloric acid and acetic acid with effervescence before the application of a red heat it is carbonate of lime. If it be soluble in hydrochloric acid, but not in acetic acid, without effervescence before, but with effervescence after heating to redness, it is oxalate of lime; if it dissolves in hydrochloric acid, without effervescence either before or after exposure to a red heat, it may be either ammoniaco-magnesian phosphate, phosphate of lime, or the mixture of the two preceding salts. If the acid solution yield a white crystalline precipitate with excess of ammonia, and the calculus is rendered very fusible by the admixture of a small quantity of phosphate of lime (bone earth) it is ammoniaco-magnesian phosphate; if excess of ammonia produces an amorphous precipitate and the calculus is readily fused after, but not before the addition of some ammoniaco-magnesian phosphate, it consists of phosphate of lime; if, again, the acid solution yields a mixed crystalline and amorphous precipitate, with excess of ammonia, and the calculus is readily fusible, without any addition, it consists of the mixed phosphates, and is commonly designated as the fusible calculus.

These remarks will, I hope, render the following table readily intelligible.

Table for Examining Urinary Calculi.

1. By Heat.	2. By Acids.	3. By Alkalies.	Nature of Calculus.	Additional Tests
Destroyed by heat.	With nitric acid, red .	Soluble in carbonate of potash, evolving ammonia..................	Urate of ammonia ...	Soluble in water when boiled.
		Soluble in carbonate of potash, evolving no ammonia	Uric acid ...	Not soluble in water when boiled.
	With nitric acid, not red	In ammonia soluble, crystallising when evaporated	Cystic oxide	Soluble in strong caustic potash; the solution gives sulphuret of lead.
		In ammonia soluble, not crystallising when evaporated...........	Uric or xanthic acid.	Dissolves without effervescence in nitric acid, leaving a lemon-coloured residue; soluble in strong sulphuric acid, not precipitated by dilution.
		In ammonia with difficulty soluble, not crystallising.	Fibrine......	With nitric acid becomes yellow.
Not destroyed by heat.	With hydrochloric acid, soluble; before heat, effervesces.	Solution in acid, when neutralised, gives a white precipitate with carbonated alkalies & oxalate of ammonia .	Carbonate of lime.......	Soluble in dilute acetic acid, with effervescence.
	With hydrochloric acid, soluble; after heat, effervesces ...	Solution in acid, when neutralised, gives a white precipitate with carbonated alkalies & oxalate of ammonia .	Oxalate of lime.......	Insoluble in acetic acid. Decomposed by strong sulphuric acid, yielding carbonic acid and carbonic oxide.
	With hydrochloric acid, soluble without effervescence, or before or after heat.	Solution in acid, with excess of ammonia, gives a white crystalline precipitate	Phosphate of ammonia and magnesia.	With phosphate of lime (bone earth), is very fusible before the blowpipe.
		Solution in acid, with excess of ammonia, gives an amorphous white precipitate ...	Phosphate of lime.	With phosphate of magnesia and ammonia, is very fusible before the blowpipe.
		Solution in acid, with excess of ammonia, gives a white, partly crystalline, partly amorphous precipitate.	Mixed phosphates....	Easily fusible without addition before the blowpipe.

After this brief introduction, I proceed to a more detailed description of the several recognised species of urinary calculi. These I have arranged in the following order; and in treating of each I shall explain the method of examining their chemical constituents:—

1. Uric or lithic acid.
2. Urate or lithate of ammonia.
3. Uric or xanthic oxide.
4. Cystine or cystic oxide.
5. Oxalate of lime.
6. Phosphate of lime.
7. Phosphate of magnesia and ammonia.
8. Mixed phosphates, or fusible calculus.
9. Carbonate of lime.
10. Alternating calculus.
11. Fibrinous calculus.
12. Prostatic calculi and concretions.

Uric Acid Calculus.—Uric acid is by far the most frequent constituent of urinary calculi, either alone or in combination with bases, as urate of ammonia, lime, &c. The calculi consisting of uric acid alone, or merely in a state of mixture with a small quantity of colouring matter, are more common than those of any other single constituent. The relative number of pure uric acid calculi in the Museum of the Royal College of Surgeons is one-third of the whole collection; in that of St. Bartholomew's Hospital, 1 : $11\frac{8}{11}$; in Guy's Hospital, 1 : 5; in the Norwich Hospital, 1 : 4; in Swabia, 1 : $11\frac{4}{7}$; and in Copenhagen, 1 : 5. The general average deduced by Dr. Prout from these data is nearly 1 : $6\frac{1}{2}$.

The relative proportions of those composed chiefly of uric acid mixed with urate of ammonia, and of urate of ammonia with minute proportions of urate and oxalate of lime and phosphates is in St. Bartholomew's as 1 : 7 ; in Guy's Hospital, 1 : 4 ; in the Norwich Hospital, 1 : 1¼; in the Manchester Hospital, 1 : 2½; in the Bristol Hospital, 1 : 3 ; in Swabia, 1 : 10; and in Copenhagen, 1 : 4½ ; giving a general proportion of 1 : 3½. If the calculi be included in which the nucleus is formed of lithic acid, we have the following as the proportions in these collections ; in the Royal College of Surgeons, 1 : 1·4 ; in St. Bartholomew's Hospital, 1 : 1¾ ; in Guy's Hospital, 1 : 4 ; in the Norwich Hospital, 1 : 1¼ ; in the Manchester Hospital as 1 : 1¾ ; in the Bristol Hospital, 1 : 2½ ; in the Manchester, 1 : 1¾; in Swabia, 1 : 1⅙, and in Copenhagen 1 : 1⅕ of the whole, the average proportion being 1 : 1½. The proportion of calculi into which uric acid enters in larger or smaller proportions as one of the constituents in the collection of the College of Surgeons is to the whole numbers as 1 : 1·36.

Two chief varieties of the uric acid calculus have been observed ; the one consisting of those in which the uric acid is deposited in more or less distinct concentric layers, giving the section of the calculus a laminated appearance ; the other variety in which the acid is deposited in a confused mass of crystalline amorphous grains ; but these varieties are often mixed or pass into each other.

The laminated uric acid calculus shows on section a series of concentric circles ; a semi-crystalline and compact structure ; a smooth surface, sometimes granular or even finely tuberculated, but if so the tubercles are smooth and polished. When broken it separates into angular fragments whose surface is fibrous, as if it were composed of crystalline fibres radiating from the centre to the circumference. The fracture occurs both in the direction of the radiating fibres and of the concentric layers. The fractured surface of the more compact calculi has a vitreous lustre.

The calculi in which no lamellæ are seen, either consist of an aggregation of large crystalline grains firmly adherent to each other, and presenting a radiated appearance, or they have a porous and earthy structure as if formed of loosely-cohering fibres. These calculi are less regular, have a rough surface, a granular and unsymmetrical fracture, and are most frequent in the kidneys. The nucleus of the laminated variety frequently presents this character. This form of calculus is more liable than the compact laminated variety to spontaneous fracture in the bladder. Calculi are sometimes seen which present cracks in the direction of the radiating fibres, indicating that the manner in which this very curious phenomenon occurs is probably produced by some unequal density in the deposits.

The colour of the uric acid calculus varies from pure white to a deep brownish red. The exact nature of the colouring matter, which exists only in very small proportion in even the deepest coloured specimens, is altogether unknown, but it probably is of the same character as the colouring matter of the urine, so often seen in the crystals of uric acid deposited from that fluid, and known as the red sandy deposit.

There is another sub-variety of the uric acid calculus which is very common. It is known as the pisiform calculus. This form is seldom solitary; many may exist at the same time in the bladder, and some may be voided by the urethra. These calculi are rarely larger than a common bean or large pea, they have an irregular angular shape produced by attrition against one another, are crystalline at the centre, laminated near the surface, and often coated with a thin layer of urate of ammonia.

The specific gravity of the uric acid calculus is usually from 1·5 to 1·786; but specimens have been observed in which the density was so low as 1·276.

Uric acid, when quite pure, is white, very sparingly soluble in water, one part of the acid requiring about 15,000 parts of cold and 1,932 parts of boiling water to bring it into solution, from which it is again deposited in the form of a granular powder composed of minute crystals of very variable form, figured in the preceding description of the constituents of the urine. It is absolutely insoluble in alcohol or ether, but dissolves very readily in solutions of caustic potash or soda, especially when heated; in phosphate and biborate of soda, but not in solutions of the alkaline bicarbonates, and is precipitated from these solutions by acids. Nitric acid dissolves it with effervescence, the uric acid is decomposed, and equal volumes of carbonic acid and nitrogen are evolved. Sulphuric and hydrochloric acids do not affect it. When heated, it blackens and is gradually consumed, leaving no ash if perfectly pure. Uric acid is a feeble acid, but combines with bases and forms salts with them. The alkaline urates are sparingly soluble, but very much more so than the pure acid. The urate of potash dissolves in 140 parts of cold and 85 of boiling water, according to Liebig, but Berzelius states that it requires no less than 480 of cold water for solution. The urate of soda, a very interesting salt, since it forms the gouty concretions known as chalk-stones, is much less soluble than the corresponding salt of potash, requiring 372 parts of cold and 124 parts of boiling water for solution. Urate of lime, small proportions of which exist in many calculi, forms shining white plates or needles, readily soluble in boiling water, but deposited from it as the solution cools.

Uric acid calculi are readily distinguished by a simple chemical analysis. When a fragment is heated to redness on a slip of metal, it blackens and gradually consumes, yielding hydrocyanate and carbonate of ammonia, and a small white ash remains, which is found to be pure lime produced by the presence of minute proportions of oxalate or urate of lime in the calculus. When reduced to powder, and heated with liquor potassæ, the calculus readily dissolves, yielding a clear solution from which a white precipitate is thrown down by the addition of hydrochloric, nitric, or acetic acid. The precipitate is at first pulverulent, and very bulky, but on being allowed to stand in the solution for a short time it contracts very much in bulk and becomes granular. In this state, it is composed of minute crystals of uric acid readily discoverable by the microscope.

Another and very striking test is the action of nitric acid on the calculus. A small portion of the powder is to be placed in a watch-glass or evaporating dish, and a few drops of nitric acid poured on it; it is then gently heated over a spirit lamp until the greater part of the acid is driven off, when the beautiful pink colour of the murexide is developed. This reaction is perfectly characteristic of uric acid.

The other substances found in uric acid calculi are animal matter, colouring matter, urate of lime, urate of ammonia, urate of soda, and traces of the inorganic salts of the urine.

Urate of Ammonia Calculus.—Calculi composed of unmixed urate of ammonia are comparatively rare, forming only one in five hundred in the collection of the College of Surgeons, although this salt constitutes the nucleus of nearly one-third of the whole in that collection. This calculus was discovered by Fourcroy and Vanquelin in 1798, but its nature was more satisfactorily demonstrated by Dr. Prout in 1823. Calculi composed entirely of urate of ammonia seldom exceed an inch in diameter, are flattened, ovoid, smooth, of a brownish-grey or clay-colour, with frequently a tinge of green. These calculi are usually compact, earthy, and very brittle ; they consist of thin consecutive layers so closely applied to each other as to appear homogeneous, but the laminæ are easily separated. They are almost peculiar to childhood, seldom if ever occurring after puberty, and their formation is accompanied by great constitutional disturbance and irritation.

Urate of ammonia is a common deposit from urine when that fluid has an alkaline reaction, and it usually carries down with it a greater or less proportion of colouring matter, which gives it a yellow or brown tinge. In a pure state this salt is perfectly white ; it is much more soluble in water than uric acid ; it requires, according to Liebig, 1,727 parts of cold, and 243 of boiling water for solution ; but the greater part of the salt is deposited on cooling in microscopic acicular crystals. The presence of chloride of sodium in the liquid, in the proportion of 2·5 to 1·000, enables it to take up more than double the quantity of the salt, and it is no longer deposited by cooling or evaporation in the crystalline, but in the peculiar amorphous condition in which it is ordinarily deposited from urine.

The calculus decrepitates when exposed to the blowpipe, and consumes much in the same manner as the uric acid calculus ; the remaining ash is, however, more copious, and consists either of pure lime or lime mixed with phosphates. The presence of ammonia is shewn by heating a small quantity of the powder with liquor potassæ, when ammonia is disengaged in abundance, and may be detected by its odour, and by holding a rod moistened with hydrochloric acid over the liquid ; or the ammonia may be determined by heating the calculus with hydrochloric acid, which combines with the ammonia, forming hydrochlorate of ammonia, which may be afterwards precipitated by bichloride of platinum, with the usual precautions. The uric acid is readily precipitated from the solution in caustic potash by either of the stronger acids.

On account of the more ready solubility of urate of ammonia, it may be separated from uric acid in cases where it exists in even small proportions, by boiling the finely powdered calculus in water, pouring off the hot solution, and allowing it to cool, when the urate of ammonia is deposited either in small stellated crystals or in an amorphous condition. It is also soluble in alkaline bicarbonates, which is not the case with uric acid.

Urate of ammonia is often associated with oxalate of lime in calculi ; in fact, the oxalate of lime diathesis is frequently preceded by a condition of the urine which favours the deposit of urate of ammonia, so that the nucleus is perhaps formed of urate of ammonia, while the succeeding layers are a mixture of these salts. These calculi often contain a small quantity of urate of lime. The nucleus presents the character of urate of ammonia decrepitating violently when heated, whereas the exterior layers are proved to contain both these salts by the tests already indicated for urate of ammonia, and those which will be given in the description of the oxalate of lime calculus. Urate of ammonia is also frequently associated with the earthy phosphates, either as a nucleus or in alternate layers, or mixed in various proportions with the other constituents.

Xanthic or Uric Oxide Calculus.—This calculus is more rare than any other, only four specimens having been discovered. It was first described by Marcet, who ascertained the properties of this curious substance, which in composition differs from uric acid only in containing one equivalent of oxygen less than the acid. The specimen examined by Marcet no longer exists. Some minute specimens were examined by Laugier ; but one calculus weighing 338 grains, and about the size of a pigeon's egg was extracted by Langenbeck, and another is mentioned by Dulk. The College of Surgeons possesses only a fragment of the calculus extracted by Langenbeck.

These calculi are of a light or cinnamon-brown colour externally, and a brownish flesh colour in the interior; their surface is smooth and polished; they are compact, but consist of concentric layers easily separable, without fibrous radiations or crystalline structure, and they assume a waxy lustre when rubbed or scraped. In point of hardness they resemble calculi of uric acid.

Uric or xanthic oxide is soluble in liquor potassæ, from which it is precipitated by acids as a white powder, which becomes light yellow by drying, and acquires a resinous lustre by gentle friction. It differs from uric acid by dissolving without effervescence in nitric acid, and the solution yields a lemon-yellow residue, partially soluble in water. This residue dissolves in liquid ammonia, forming a reddish-yellow solution, and Mr. Taylor states that the same effects are produced when the xanthic oxide is mixed with a considerable proportion of uric acid; indeed its presence appears to prevent the formation of the pink colour produced by the successive action of nitric acid and ammonia on uric acid, changing the colour to a brick-red. Xanthic oxide and uric acid are equally soluble in strong sulphuric acid, but the latter is precipitated by the addition of water, while the former is retained in solution, and on this difference the process for separating these substances is founded.

After dilution of the sulphuric acid solution, the precipitated uric acid is separated, and the xanthic oxide may be removed by saturating with ammonia, evaporating to dryness, and dissolving out the sulphate of ammonia with water. The solutions of xanthic oxide in caustic alkalies are not precipitated by hydrochlorate of ammonia, which throws down uric acid. Caustic alkalies and alkaline carbonates dissolve xanthic oxide, and it is more soluble in liquid ammonia than uric acid. It gives out a peculiar odour when burned, differing from that emitted by uric acid or cystic oxide, and unlike uric acid, it yields no urea by destructive distillation. By these characters this rare calculus may be distinguished.

Cystic Oxide Calculus.—These calculi are very rare. They are found only in four out of seven museums mentioned by Dr. Prout, in his admirable work on "Urinary Diseases;" while the large collection of the College of Surgeons contains only one or two specimens. The general proportion is said to be 1 : 304. The term cystic oxide is a misnomer, since this substance is a product of the kidneys, and not of the bladder. Nor is it peculiar to the human body, a calculus of this kind having being found in the bladder of a dog.

Cystic oxide calculi are usually small, rounded, of a yellowish colour, with a smooth, semi-transparent and glistening surface. They resemble those composed of ammoniaco-magnesian phosphate in general appearance, but are more compact in structure. They have a soft consistence, the section is confusedly crystalline, and not laminated. The fracture exhibits a crystalline structure. The largest known calculus of this substance is in the museum of University College, London, which weighs 850 grains, and is formed of concentric semi-crystalline layers. They are said by Dr. Golding Bird to undergo a change of colour from yellowish brown to a fine bluish-green when long kept.

The disposition to the formation of these calculi is often hereditary, two or more members of the same family having presented the cystic oxide diathesis. Cystic oxide is not unfrequently found as a deposit in the urine, which then has a greenish-yellow appearance, a disagreeable odour, a neutral or slightly acid reaction. It rapidly becomes alkaline, and deposits cystic oxide, or an oily film forms on the surface, consisting of cystic oxide mixed usually with ammoniaco-magnesian phosphate, and at the same time uric acid and urea are more or less deficient in quantity. Dr. Golding Bird obtained 0·43 of a grain from 1000 grains of urine of sp. gr. 1·014.

Cystic oxide or cystine is remarkable for its solubility in a large number of menstrua. It is alike soluble in the mineral acids and in the caustic alkalies, and the solutions yield colourless granular crystals by spontaneous evaporation. It is sparingly soluble in pure water, and insoluble in alcohol, acetic, tartaric, and citric acids, and in solution of bicarbonate of ammonia. During the evaporation of the solution in caustic ammonia, the ammonia escapes, and crystals of pure cystine are deposited either as hexahedral prisms or plates. From its alkaline solutions it is precipitated by acetic acid in the form of a white crystalline powder. Cystic oxide is remarkable for containing 26·58 per cent. of sulphur, and it was ascertained that the large calculus in University College yielded 19 per cent. of this substance. When heated cautiously on platinum foil it is surrounded by a blue circle, which disappears on the application of a stronger heat, and at the same time it gives out a peculiarly disgusting odour.

These calculi are distinguished from all others, except those of uric oxide, by their ready solubility in acids and alkalies, especially by dissolving readily in liquid ammonia. They are best distinguished by dissolving a fragment in liquor ammoniæ, and allowing the solution to evaporate spontaneously on a slip of glass. The residue examined by the microscope is found to consist of minute six-sided tables or prisms, characteristic of cystic oxide. The peculiar nauseous odour when burned is also diagnostic of this calculus. It is distinguished from uric (xanthic) oxide by its solubility in carbonate of potash and dilute hydrochloric acid, and from uric acid by its solubility in dilute hydrochloric, phosphoric, and oxalic acids. Liebig has given a very characteristic test for this substance, depending on the presence of sulphur. He directs it to be dissolved in a strong solution of caustic potash, and a solution of acetate of lead added as long as no oxide of lead is deposited. The mixture is then boiled, the cystic oxide is decomposed, ammonia is disengaged, sulphuret of lead is deposited, giving a black colour to the liquid, and after filtration oxalic acid is found in the clear solution.

Cystic oxide calculi are usually free from admixture of other substances, but uric acid sometimes forms the nucleus, and a layer of uric acid has been found surrounding a nucleus of cystic oxide. It is also occasionally associated with ammoniaco-magnesian phosphate and carbonate of magnesia.

Oxalate of Lime Calculus.—Considerable discrepancy occurs in the relative numbers of these calculi in different collections. The proportion in the Museum of the College of Surgeons, where the entire calculus is composed of this salt is as 1 : 20 ; in St. Bartholomew's as 1 : 15 ; and in Guy's Hospital as 1 : 14½ ; but when those with a nucleus of urate of ammonia are included, the proportion is increased in the collection of the College of Surgeons to 1 : 3½. If all the calculi be taken in which oxalate of lime exists in any amount, then the proportion is, according to Dr. Prout, in the museum of St. Bartholemew's Hospital, 1 : 4⅓ ; in Guy's, 1 : 4 ; in Norwich, 1 : 7½ ; Manchester, 1 : 6⅙ ; Bristol, 1 : 3⅓ ; Swabia, 1 : 27 ; and Copenhagen, 1 : 2⅒. The average proportion in all these collections is 1 : 4⅓.

It would seem from the foregoing statements that the oxalate of lime calculus is rarely pure, but associated with urate of ammonia, uric acid, urate and carbonate of lime, colouring matter and blood.

The oxalate of lime calculus has been long known under the name of mulberry calculus, so called from the tuberculated surface it usually presents, which gives it somewhat the appearance of that fruit. This calculus has usually a rounded shape; its surface is dark brown or almost black. The internal structure when exposed by section is imperfectly lamellated, the consecutive layers forming waving lines, and its colour is such as to give the surface of the section a strong resemblance to knotted heart of oak, varying from white to bright yellow, yellowish-brown or dark green. The structure is very compact and hard. The tubercles when divided appear to consist of stellate or acicular needles, arranged perpendicularly to the surface, and owing to the tendency of oxalate of lime to form nodular masses, it is by no means improbable that the whole calculus is made up of such nodules. Two other varieties of the oxalate of lime calculus exist; one of these is crystalline throughout, its surface studded with brilliant crystals of the oxalate in acute-angled octahedra, and these are nearly pure oxalate of lime.

The other form consists of small rounded masses, with a smooth polished surface, known as the hemp-seed calculi. They are occasionally crystalline at the centre, and laminated towards the surface; but the laminæ are so fine as to give the section almost a compact appearance. They are composed of mixed oxalate and phosphate of lime in variable proportions.

The oxalate of lime calculus is distinguished from other calculi by swelling up, when heated on platinum foil, or in the blowpipe flame, and leaving a copious white ash, which is either caustic lime, or a mixture of quicklime and carbonate of lime, according to the intensity and duration of the heat; but usually the latter. This ash exhibits an alkaline reaction with moistened turmeric or reddened litmus paper, turning the former brown, and restoring the blue colour of the litmus; is soluble with effervescence in hydrochloric acid, and the solution gives no precipitate when saturated with ammonia, but a copious white deposit of oxalate of lime on the addition of oxalate of ammonia. The calculus itself is insoluble in acetic, but soluble in moderately strong nitric and hydrochloric acids, without effervescence, and the latter solution yields a white precipitate with excess of ammonia. Caustic potash has little or no action on this calculus, but when it is reduced to a fine powder, and boiled for some time with a solution of carbonate of potash, mutual decomposition ensues, and oxalate of potash and carbonate of lime are produced. If then the liquid be filtered, the carbonate of lime remains on the filter, which must be washed, and being heated to dull redness indicates the quantity of lime. Acetate of lead is now added to the pellucid solution until it ceases to give any further precipitate, oxalate with carbonate of lead are thrown down, collected on a filter, well washed, suspended in water, and a current of sulphuretted hydrogen passed through the liquid until the whole of the lead is converted into sulphuret; the liquid again filtered and evaporated, yields crystals of pure oxalic acid.

This calculus is distinguished from phosphate of lime or ammoniaco-magnesian phosphate by its insolubility in acetic and dilute hydrochloric acids, and the alkaline reaction of the ash on moistened turmeric paper. When oxalate of lime and phosphates exist in the same calculus they may be separated by dissolving the calculus in strong hydrochloric acid, precipitating by ammonia, and digesting the residue in acetic acid which dissolves the phosphates, but leaves the oxalate untouched. Acetic acid will separate the urate from the oxalate by dissolving out the former.

Phosphate of Lime Calculus.—Calculi of pure phosphate of lime are rare. They were first described by Dr. Wollaston in the Philosophical Transactions for

1797. There are two varieties, the one evidently of renal, the other of vesical origin. Although entire calculi of pure phosphate of lime, are uncommon, this substance is often found nearly pure in the laminæ of alternating calculi.

Calculi of phosphate of lime are stated by Dr. Prout to be in the ratio of 1 : 32¼ in the Museum of St. Bartholomew's Hospital; as 1 : 29 in Guy's; as 1 : 132 in Norwich; and 1 : 155 in that of the Bristol Hospital. No specimen exists in the Museum of the College of Surgeons, or in the other collections mentioned by Dr. Prout. The general ratio of these calculi to others is as 1 : 117.

The calculi of renal origin are composed of the neutral phosphate of lime, those of vesical origin of phosphate of lime, similar to that of bones, and are thence often called "bone-earth calculi." The latter are more common than the former.

Calculi of neutral phosphate of lime are usually pale brown, with a smooth polished surface, regularly laminated, and the laminæ so slightly adherent as to be easily separable into concentric crusts. In some, radiating lines are seen in a direction perpendicular to the laminæ, as if the latter were composed of crystalline fibres. These calculi contain animal matter, which is precipitated from the alkaline urine with the phosphate of lime. When heated before the blowpipe, or on platinum foil in the flame of the spirit-lamp, they char, give out the odour of burned feathers, and leave a white ash which fuses at a higher temperature into an opaque globule. They are soluble in hydrochloric and nitric acids, sparingly so in acetic acid, and the phosphate of lime is precipitated in a white gelatinous form by the addition of alkalies. Oxalate of ammonia throws down oxalate of lime when the solution is nearly or quite neutral. As the ammoniaco-magnesian phosphate is also readily fusible, it must be previously ascertained that none is present.

Bone-earth is said by Simon never to occur unmixed in the form of a calculus; but Dr. Taylor has described some specimens of vesical origin in the catalogue of the Museum of the College of Surgeons, as consisting entirely of this salt. These are in irregular masses resembling mortar, or a granular semi-crystalline powder, enveloped in a tenacious mucus. They are distinguished from the preceding by first charring, then leaving a bulky white ash which is infusible before the blowpipe.

Ammoniaco-Magnesian Phosphate Calculus.—This double salt, commonly known as the "triple phosphate," rarely forms an entire calculus, but is a very common constituent of other calculi, either mixed with phosphate of lime, as in the fusible calculus, or forming layers in alternating calculi. The proportion of calculi consisting of pure phosphate of magnesia and ammonia, in the collection of St. Bartholomew's, is as 1 : 129; in Guy's, as 1 : 43½; in the Bristol Hospital, 1 : 218; in Copenhagen, 1 : 19½; while the other collections enumerated by Dr. Prout contain no specimen. Three calculi of this salt exist in the Museum of the College of Surgeons, which gives the proportion in that collection as 1 : 200. The general proportion in all the collections is 1 : 126⅔. Ammoniaco-magnesian phosphate is a frequent deposit from alkalescent urine, or healthy urine which has been kept until rendered ammoniacal by decomposition of its urea. In such urine it is frequently deposited as a white brilliant crystalline powder, commonly designated *white sand;* but it is usually mixed with more or less phosphate of lime.

Calculi of ammoniaco-magnesian phosphate are generally white, uneven and roughened by the projecting summits of the crystals, which are transparent and brilliant in the fresh state, but become opaque and lose their lustre after keeping for some time. They are either not laminated or imperfectly so, are friable, and easily reduced to powder. But occasionally they are hard, compact, and laminated ; exhibiting a semi-transparent crystalline fracture, which gives them the aspect of alabaster.

Two distinct salts are found in these calculi ; one of them, the neutral phosphate of magnesia and ammonia, crystallizing, according to Wollaston, in rectangular prisms, the usual form being the triangular prism, terminated by three or six-sided pyramids, which forms a film on the surface, or is deposited in urine that has become slightly alkalescent, or is thrown down by the addition of a small quantity of ammonia ; the other, the bibasic phosphate, is deposited in stellated or foliated crystals, from strongly alkaline urine, or by adding a large excess of ammonia to healthy urine, and forms an iridescent pellicle on its surface, usually mixed with phosphate of lime. Neither of these salts exist naturally in the urine ; they are formed by the combination of ammonia produced by the decomposition of urea with the phosphate of magnesia, present in greater or smaller proportion in all urine.

The deposition of phosphates is usually accompanied by considerable nervous irritation, lumbar pains, and great debility.

These calculi are recognised by giving off ammonia and watery vapour when heated in the blowpipe flame, leaving a large residue of phosphate of magnesia which fuses with difficulty into a white porous enamel. If a small quantity of phosphate of lime be added, the fusion is more easy and complete. They are readily soluble in dilute acids, including acetic acid, and the original salt is precipitated by ammonia as a white crystalline powder. When treated with caustic potash (liquor potassæ) ammonia is evolved.

Fusible Calculus.—The calculi commonly known by this name, consist of a mixture of phosphate of magnesia and ammonia, with phosphate of lime in very variable proportions.

These calculi bear a considerable proportion in all collections, being in St. Bartholomew's, as 1 : 12$\frac{1}{10}$; in Guy's, 1 : 3$\frac{1}{2}$; in Norwich, as 1 : 19 ; in Manchester, 1 : 8$\frac{1}{2}$; in Bristol, 1 : 12 ; in Swabia, 1 : 11$\frac{1}{2}$; and in Copenhagen as 1 : 19$\frac{1}{2}$; according to Prout. The relative number in the Museum of the College of Surgeons, is 1 : 13$\frac{1}{2}$, while that in all the collections is 1 : 12$\frac{1}{4}$.

Fusible calculi are white, grey, or dull yellow ; they are more friable than any others, being sometimes so soft as to whiten the fingers like chalk when handled ; these are not laminated. Others have distinct lamellæ with sparkling crystals of triple phosphate between them, which are so slightly adherent as to be readily separated ; others again are composed of crystals aggregated into a confused mass. The calculi themselves are usually globular or ovoid, but sometimes very irregular in shape, being occasionally moulded to the cavity in which they are formed ; they often attain a large size, and sometimes fill the whole cavity of the bladder ; in this case impressions of the folds of the mucous membrane are visible on the surface, and when two or more exist in the bladder, they take a cubic or tetrahedral form. Excrescences composed of triple phosphate are sometimes found, resembling pearls in texture. The ammoniaco-magnesian phosphate is most abundant in those which have a shining crystalline texture, the phosphate of lime in the earthy and amorphous variety. The fusible calculus is found in all parts of the urinary organs, and in large cysts or cavities in the prostate gland.

The earthy phosphates are, according to Mr. Taylor, rarely succeeded by any other deposit ; the only exceptions, that in the Museum of the College of Surgeons, being one in which layers of mixed phosphate exist in an oxalate of lime calculus, and one in St. Bartholomew's Hospital, in which a fusible calculus is surrounded by a layer of uric acid.

It would seem probable that the two ingredients of these calculi have a distinct origin ; the ammoniaco-magnesian phosphate being derived from the urine, while the phosphate with a small proportion of carbonate of lime is secreted together with mucus by the irritated mucous membrane. This is exemplified very remarkably in calculi formed around a foreign body accidentally introduced into the bladder. The foreign body is first incrusted with phosphate and carbonate of lime derived from the mucous membrane of the bladder, and subsequently the irritation being extended to the kidneys the urine becomes alkaline, and ammoniaco-magnesian phosphate is deposited. In this case the layers near the nucleus contain more phosphate of lime than those near the surface, and when the calculus has been retained in one position, the greatest quantity of phosphate of lime is found on the side in contact with the mucous membrane of the bladder. If the urine be highly alkaline the mixed phosphates will be derived from this fluid, which may arise either from unnatural proneness of the urea to decomposition, or from long retention of urine in the bladder. As a secondary deposit the mixed phosphates are very common, few calculi remaining for a long period in the bladder without being incrusted with them. The uric acid calculus is least subject to this incrustation.

These calculi commonly contain urate of ammonia and animal matter often in considerable proportion, together with carbonate and urate of lime and uric acid.

The fusible calculus is characterised, as its nature implies, by giving off ammonia, and fusing readily before the blowpipe into a greyish-white transparent, or semi-opaque globule; and this when moistened does not yield an alkaline reaction with the turmeric paper, by which it is distinguished from the oxalate of lime calculus. The two chief constituents may be roughly separated, and their relative proportions estimated, by digesting a portion of the calculus previously reduced to fine powder with very dilute acetic or sulphuric acid, which dissolves the ammoniaco-magnesian phosphate, leaving the phosphate of lime untouched.

In a complete analysis of this calculus, fat and extractive matter must be first extracted from the powdered calculus by ether and alcohol. The urates must be removed by repeated boiling in distilled water, in which they are soluble. The residue is next dissolved in hydrochloric acid, and if anything remain it is either uric acid or oxalate of lime. The uric acid may be separated from the oxalate by liquor potassæ, and the latter recognised by the tests I have already described under the head of oxalate of lime calculus.

If carbonate of lime be present, effervescence occurs during the solution of the calculus in hydrochloric acid. In this case the mixed phosphates are precipitated by ammonia, and to the filtered liquid oxalate of ammonia is added to throw down the lime. The precipitated phosphates are next digested in strong acetic acid, which dissolves the ammoniaco-magnesian phosphate with a small proportion of the phosphate of lime. The lime is first precipitated by oxalate of ammonia, and the phosphate of magnesia, as ammoniaco-magnesian phosphate, by ammonia. The animal matter, which resembles vesical mucus, is seen floating in the solution of the calculus in hydrochloric acid, and may be separated by filtration.

These salts may be readily detected by dissolving a small fragment of the calculus in hydrochloric acid, precipitating by ammonia, and examining the precipitate under the microscope, when the triple phosphate is seen in the form of stellate crystals interspersed with the amorphous granular phosphate of lime.

Carbonate of Lime Calculus.—Calculi consisting of this salt, associated only with a small proportion of animal matter, are extremely rare in the human subject, but common in herbivorous animals, in whose concretions the carbonate of lime is usually mixed with carbonate of magnesia; but carbonate of lime is often found in variable proportion in the oxalate of lime and phosphatic calculi. Brugnatelli was the first to recognise this calculus: the specimen analysed by him was about the size of a pea, and contained some oxide of iron. Dr. Prout analysed some small calculi, consisting entirely of carbonate of lime which were white and friable. Mr. Smith describes eighteen removed from the bladder of a young man, and Brugnatelli forty-eight from a similar source, and sixteen the size of a nut from a woman.

These calculi may be described as small—the largest not exceeding the size of a large almond, white or grey, but sometimes yellow, brown, or red, and the surface dusted over with a white powder. The concretion shows no concentric laminæ, but irregular waved lines similar to those in the mulberry calculus. They are sometimes so hard as to require the assistance of the lapidary's wheel to divide them, and are then capable of receiving a high polish. Others passed by the urethra of a rounded and flattened form, are compact, lamellar, and light brown. Carbonate of lime calculi are distinguished by dissolving with effervescence in dilute hydrochloric acid, the solution yielding no precipitate with pure ammonia, but a copious white precipitate of oxalate of lime when oxalate of ammonia is added, and also a white precipitate of carbonate of lime, by the addition of alkaline carbonates. If phosphate of lime be present in the calculus, it is precipitated from the solution in hydrochloric acid by ammonia.

No specimens of this calculus exist in the museums enumerated by Dr. Prout, nor in that of the College of Surgeons.

Alternating Calculi.—A very large proportion of the calculi formed in the human urinary apparatus are of this character, owing to the successive changes in the condition of the system, and consequently of the urinary secretion. These calculi exhibit a series of alternating layers, differing in chemical composition. They may be composed of two layers: *e. g.* a calculus may have a nucleus of uric acid, covered by a deposit of urate of ammonia, oxalate of lime, phosphate of lime, or mixed phosphates; the nucleus may consist of oxalate of lime, followed by uric acid, urate of ammonia, phosphate of lime or mixed phosphates. Other calculi have three layers; thus a nucleus of uric acid, followed by deposit of oxalate of lime and mixed phosphates, or oxalate of lime and uric acid; or a nucleus of oxalate of lime, covered by uric acid and urate of ammonia, or a nucleus of mixed phosphates followed by phosphate of lime and mixed phosphates. Others, again, consist of four or even more layers: thus a nucleus of uric acid incrusted by urate of ammonia, uric acid, and urate of ammonia; or oxalate of lime, followed by uric acid, oxalate of lime, phosphate of lime, &c.

The proportion of alternating calculi of two layers to the whole collection in St. Bartholomew's is as 1 : 2½; in

Norwich, $1 : 2\frac{2}{3}$; in Manchester, $1 : 2\frac{5}{6}$; in Bristol, $1 : 3$; in Swabia, $1 : 1\frac{1}{3}$; and in Copenhagen as $1 : 2\frac{1}{2}$, giving a general proportion of $1 : 2\frac{2}{3}$.

Those of three deposits are in St. Bartholomew's as $1 : 6$; in Norwich, $1 : 6$; in Manchester, $1 : 26\frac{5}{7}$; in Copenhagen, $1 : 4\frac{1}{2}$; yielding a general average of $1 : 8\frac{1}{8}$.

Those of four deposits are stated to be in the Norwich collection as $1 : 26\frac{1}{2}$.

The deduction to be drawn from all these data is, that alternating calculi of all kinds form somewhat more than half of the whole.

The order in which different deposits succeed each other in these calculi is of considerable interest, as elucidating the successive changes in the condition of the body, corresponding with the progress of the disease. Dr. Prout has calculated that oxalate of lime succeeds uric acid in the ratio of $1 : 15\frac{2}{3}$, whereas uric acid succeeds oxalate of lime in $1 : 13\frac{5}{23}$; so that the alternation of these two substances is nearly equal. He states that oxalate of lime follows urate of ammonia more frequently than uric acid, in the proportion of $1 : 9\frac{5}{8}$, whereas urate of ammonia follows oxalate of lime in $1 : 38$. Phosphates succeed uric acid in the ratio of $1 : 9\frac{1}{6}$; the urate of ammonia, $1 : 12\frac{1}{2}$; and oxalate of lime, $1 : 7\frac{1}{2}$; whereas only three instances occur in the museums already quoted in which phosphates are succeeded by uric acid or urate of ammonia; and oxalate of lime incrusts the phosphates only in the proportion of $1 : 283\frac{1}{3}$. The general ratio in which phosphates succeed other deposits in all the collections is $1 : 4\frac{1}{15}$. From these results Dr. Prout educes the law, that in urinary calculi a decided deposition of the mixed phosphates is not followed by other deposits.

Fibrinous Calculus.—This rare calculus was first recognised and described by Marcet. Dr. Prout states that he has seen several specimens, but none are enumerated in the collections to which I have repeatedly referred. Their relative frequency is, therefore, unknown.

Fibrinous calculi are described by Dr. Prout as being usually of an amber colour and waxy consistence, with more or less of a fibrous texture. They are, when unmixed, wholly combustible, giving out an odour of burnt horn, and leaving only a small quantity of ash; insoluble in water, alcohol, or ether, but soluble in caustic potash, from which a precipitate is thrown down by hydrochloric acid. They are soluble in acetic acid, and ferrocyanide of potassium produces a white precipitate in the solution. Nitric acid slowly dissolves these calculi. Dr. Prout asserts that they really consist of fibrine, while others consider that they are formed of vesical mucus or albumen.

Prostatic Calculi and Concretions will be described with other affections of the prostate gland.

CHAPTER XV.

CAUSES OF STONE.

The importance of acquiring a knowledge of the causes of urinary calculi must be apparent to every one who considers that it affords the only means by which we can prevent the formation of this disease, the most painful in the catalogue of human maladies, as well as its recurrence after the sufferings and hazards of lithotomy.

In former times the causes of stone in the bladder were particularly obscure. Much has been done of late by an extended knowledge of the chemical constitution of the urine, and of the concretions which form in it, to elucidate this subject. Much, however, still remains to be done before a complete account of the ætiology of calculous complaints can be given. The great principle on which the formation of calculi from the urine depends, is the saturation of that fluid with some sparingly soluble substance capable of concreting, either by itself or with the addition of a small proportion of animal matter, into a solid mass. Of the three most common kinds of substance found in urinary calculi, namely, uric acid, phosphates of the earths, and oxalate of lime, the two former belong to urine of the most healthy character. Moreover, these two kinds of substance are very sparingly soluble in water, so that by very slight changes either in the proportion of fluid, or in the circumstances which render them soluble, even to a very small extent, a deposit of solid matter is apt to occur. Indeed this would happen much more frequently than it actually does within the bladder, were it not that the temperature at which the urine is kept, so long as it remains within the body, tends to render these substances somewhat more soluble than they are in the urine after it has passed from the body and attained the temperature of the surrounding atmosphere. The same remarks apply to the third substance just mentioned, namely, the oxalate of lime, with this exception, that it does not belong to healthy urine, but is the result of some kind of morbid action, as it would seem, during the metamorphosis of the living tissues. Thus we may describe the preliminary to the production of urinary calculus as being the saturation of the urine with that substance which is about to pass into the form of a calculus. It does not, however, follow that in every case in which this kind of saturation has occurred, and the deposit of solid matter has taken place from the urine within the bladder at the ordinary temperature of the body, it becomes a calculus. It is common to regard gravel and calculous concretions as of very much the same character. It is unquestionably true, that the tendency to the formation of gravel may very readily pass into the actual production of a calculus; but it is also undeniable, that the deposit termed gravel may take place for long periods of time without ever concreting into such masses as cannot readily escape by the urethra. Hence, there appears to be some other condition necessary besides the mere sufficient saturation of the urine with the substance that is to be deposited, before a calculus is formed. This condition, probably, is, for the most part, the presence of some agglutinating matter by which the minute particles of the gravel coalesce into a nucleus. Authors are accustomed to mention the presence of foreign substances, however minute, as being sufficient to account for the transition of gravel into calculus; there is, however, another mode in which foreign substances operate which should not be lost sight of—that is, by causing irritation, and so increasing the discharge of mucus from the internal surface of the bladder, by which the qualities of the urine are often materially changed. To explain the formation of a calculus, particularly of a homogeneous calculus of any considerable size, it is necessary to suppose, not only that the saturation of the urine just referred to should occur, but that it should have a certain degree of persistence through a long period of time. Again, to account for the alternation of layers of different kinds of substance, we must suppose that at intervals the substance with which the urine is saturated changes—that a new diathesis arises for a time. This change may sometimes be the effect of the medical treatment employed to counteract the morbid character which had been first observed in the urine; at other times it has been conjectured to be the result of a temporary alteration of the urine, owing to the change in the secretion of the mucous membrane by the irritation which the calculus has produced. It must be confessed, however, that on this subject our explanations are very unsatisfactory.

The doctrine of the metamorphosis of living tissues by the agency of oxygen, has served in no small degree to improve the general ætiology of calculous complaints. It is undeniable that by the agency of oxygen and water the component textures of the living body are unceasingly changed into urea and uric acid, together with carbonic acid. It seems equally certain that the proportion of urea is great, and that of uric acid small, when this process takes place under a free supply of oxygen; that is, in proportion to the activity of respiration at the time there is a large proportion of the soluble product of this metamorphosis generated, and a small proportion of the sparingly soluble product. Hence it might justly be inferred, that as often as the respiration is defective the urine would contain an undue proportion of uric acid; or that a strong tendency to the formation of uric acid calculus should arise in states of defective respiration. And this corresponds exactly with the history of the circumstances under which calculous disorders most frequently occur; for we find all authorities on this subject agreed in describing imperfect respiration, from whatever cause that may arise, as one of the most striking conditions concerned in the production of calculi.

If we adopt Liebig's views, oxalic acid represents a portion of the urea which should be derived from the metamorphosis of the living tissues when the supply of oxygen by respiration fails—the failure not being to so great an extent as when a superabundance of uric acid appears in the urine. He even affirms that it has been remarked at Paris, that when persons affected with the uric acid diathesis remove to the country, so that the respiration becomes more developed, this condition of the urine is exchanged for the oxalic acid diathesis.

These views unquestionably point to the right direction, in which a perfect ætiology of calculous complaints is to be sought; but it cannot be affirmed, that they as yet afford a full and satisfactory explanation of their occurrence.

An important consideration, as regards the ætiology of calculous disorders, arises in connexion with the two opposite states of the urine, as acid or alkaline. The connexion of the uric acid diathesis with the presence of free acid in the system has long been remarked. And though some difficulties still attend the question, it seems undeniable that the presence of an undue proportion of acid in the urine gives a tendency to the deposition of uric acid. On the contrary, an alkaline state of the urine plainly gives origin to a deposition of earthy phosphates. When the alkali present is ammonia, the deposit consists of the phosphate of lime and of the phosphate of magnesia; when potash or soda is the cause of the alkalinity, the deposit consists of phosphate of lime only. Alkalinity of the urine depends much more frequently on the presence of ammonia than on that of either of the fixed alkalies; and this fact corresponds with what has been stated as to the rarer occurrence of phosphate of lime than of the triple phosphate, either by itself or along with phosphate of lime. The urine readily becomes ammoniacal by the decomposition of urea; and one of the most common causes of this decomposition appears to be the retention of the urine in the bladder while it is loaded with mucus derived from the urinary passages. The urine hardly becomes alkaline from the presence of potash or soda, unless during the use of these alkalies as a part of the medical treatment, whether pure or combined with carbonic acid, or with any of the vegetable acids, or the alkaline compounds, which last are well known to pass during the process of digestion into carbonates.

The statements hitherto made include nearly all that is of a general character in regard to the ætiology of calculi,—what remains to be said is of a more particular description.

It is usually stated that calculus is more common in temperate than in warm or very cold climates; some further examination, however, of this statement is still required. Humid countries, of moderate temperature, have commonly been supposed to be the chief seat of calculous complaints; and Holland, France, England, and Germany are enumerated as exhibiting the prevalence of calculous disorders in the most striking degree. With regard to the exemption of some, and especially of intertropical countries, very discordant accounts prevail. Dr. Marcet states that he learned from Dr. Scott, so well known as particularly conversant with the diseases of India, that there calculus is an unknown disease. Dr. Scott says, "the formation of stone in the urinary bladder is nearly unknown between the tropics. I have indeed not met with a single instance of it, although I have known some cases where such a disease was imparted and not removed by climate." On the contrary, Dr. Brett affirms that calculous complaints are frequent in India; he says that he has known lithotomy practised at Benares many times, and that he himself has operated on several occasions. It is not unlikely that Dr. Scott refers merely to the exemption of Europeans in India; while it is plain that what Dr. Brett speaks of is the frequency of this occurrence among the natives. He ascribes the prevalence of the disease, especially among the native children, to errors in diet, and in particular to the over free use of rancid sweetmeats and coarse unleavened bread. Dr. J. Jackson, in a letter to Mr. Crosse, of Norwich, also states that calculi are frequent throughout India, attributing their prevalence to bad diet, and in particular to the use of unfermented bread,—he also refers to the native population. Staff-Surgeon Allen states, that he inquired particularly into this subject while resident in the Mauritius, and that he found uric acid gravel to be very common among young people, and that calculi were very far from being unknown.

According to the views commonly taken, calculus is much more incident to early years than to any other period; and to old age more than to the prime of life. Hippocrates notices the fact, that infants at the breast are not exempt from the disease; and our old English author, Philip Barrough, in his *Methode of Physick*, (*lib. iii. c.* 41, *edit. quinta*, 1617,) observes, "stones in the bladder do engender oftener in children than in older folk." Some authors have of late denied that children are so subject to calculus as is commonly represented. It is certain that uric acid gravel is very frequent in children under some circumstances; and it is known that calculi have been found in the bladder even at the time of birth. When, however, children are well fed, and proper attention paid to them, distinct calculous concretions appear to be of rare occurrence; yet it is undeniable that the disease is very frequent under the age of puberty in ill-fed children. In the returns of the cases of lithotomy in the Norfolk and Norwich Hospital from 1772 to 1816, or during a period of 44 years, the total number of operations is 478, of which 227 are in children under 14.

According to Dr. Prout, the following is the relative frequency of urinary concretions at different ages.

Under 10 years of age	500
10 to 20	192
20 to 30	104
30 to 40	94
40 to 50	112
60 to 70	97
70 to 80	12

Among those beyond middle age it occurs more frequently in persons of sedentary habits than in those who lead an active life, and much more in those who indulge in luxurious living than in the temperate and abstemious. A marked connexion has hence been long observed between a calculous and a gouty tendency.* Liebig has attempted to deny the connexion between rich living and the tendency to stone in the bladder. He mentions that uric acid can only be derived from the living tissues, and that a superabundance of this substance can only arise from the rapid metamorphosis of these tissues, as under muscular exertion or the excitement of fever. It is to be remembered, however, that Liebig is more of a speculative than of a practical writer; and it is impossible to adopt an opinion which is at variance with the general experience of the medical profession. Of late years Magendie and Chossat have taken pains to illustrate the opinion which has so long prevailed as to the connexion between an over-rich diet and the production of calculus. Were we to adopt Liebig's view, we should be obliged to disbelieve the alliance between gout and full living as well as between it and calculus; since gout is manifestly connected in some measure with an excessive formation of uric acid. There is one mode in which we may attempt to reconcile the views of Liebig with the predominance of the uric acid diathesis in those who indulge in high feeding; Liebig admits that the existence of fever is accompanied with a rapid metamorphosis of the tissues and a consequent abundant extrication of uric acid. It is, however, undeniable that an excess of rich food, especially when accompanied with an undue quantity of wine, has the effect of producing febrile excitement, and thus that the metamorphosis of the tissues may take place under that deficiency in the supply of oxygen which causes a preponderance of uric acid beyond what belongs to health.

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* "Stone is commonly the constant companion of gout."—(*Sydenham, Epidem.* 1675-80.) An observation which he repeats in his epistle to Dr. Wm. Cole. See also Schroeder and Rupp, "*Disp. de Cognatione inter Arthritidem et Calculum,*" 1767.

However, although the rich, the luxurious, and the indolent, are at a certain age more prone to calculus than other classes ; the poor and the destitute do not escape in early years, for, as I have already said, the ill-fed and ill-clothed children of our labouring population are frequently afflicted with stone.

All authors who have written on this subject concur in stating that females, notwithstanding their sedentary habits, are much less subject to calculus than males; and the reason for this is apparent, besides their more temperate and regular mode of living—namely, the lesser complexity in the form and construction of the urethra in females than in males, its more dilatable nature, and the absence of the prostate gland. When a calculus descends from the kidney into the bladder, or when a calculus by any accident is formed in that viscus, it is most usually expelled during micturition by the mere efforts of the bladder to empty itself, and it is sometimes surprising to what an extent the female urethra spontaneously allows of being distended. Tulpius (*L. iii. obs.* 7) relates the case of a lady, aged 89, who spontaneously passed a calculus, per urethram, weighing three ounces and two drachms ; but it appears to have paralysed the sphincter vesicæ, as she was ever afterwards troubled with incontinence of urine.

It is a popular belief, that waters strongly impregnated with calcareous matter is apt to produce stone ; and the prevalence of this disease in Paris countenances the supposition,—a supposition which even the philosophical Hales entertained. But were this a cause, calculous disorders would be far more frequent than they are.

The water of the Seine abounds with carbonate of lime, and were the disease attributable to it, we naturally should expect the nature of the calculi would correspond with the character and quality of the water; but we know this not to be the case, and few calculi are more rare than those composed of the carbonate of lime.

Van Swieten observes, that the Caroline Hot Baths quickly incrust with a strong matter whatever bodies are immersed therein; yet they are extolled by many for their lithontriptic virtues.

The idea that the prevalence of calculous complaints in particular districts depended on the character of the water used by the population for drink, arose at a time when the ætiology of such diseases had made no progress whatever. It is plain that none of the forms of calculi correspond with the salts which exist in natural waters; and the only mode in which the salts contained in these could operate to the production of calculi, would be by causing a deposit of the salts which naturally exist in the urine. Hence, as being of a somewhat alkaline character, calcareous waters might be supposed to favour the deposit of phosphates from the urine. This, however, has not been observed, and the quantity of calcareous matter in such waters is probably too small to have any such effect. On the contrary, various calcareous waters, as Buxton, Malvern, Matlock, have had a reputation for counteracting the calculous tendency. These waters, however, act merely as diluents, washing out the saline matter from the system, being all remarkable for their extreme purity, notwithstanding that they contain a minute proportion of calcareous matter.

We have the high authority of Van Swieten for the fact, that calculous disorders are very common in Holland; and the circumstance is the more curious, considering that gin, a powerful diuretic, is the spirit most in use in that country. Nevertheless, among the Dutch who come from Europe, and inhabit Batavia (Java), stone is a very rare disease, although their manner of living does not differ from that pursued at home. Denys, who resided in that island for some years, tells us that he could find only two persons who were obliged to submit to the operation of lithotomy. He further observes, that the water they drink, flowing from the neighbouring mountains, is much impregnated with earthy matters.

Calculous diseases are well known to prevail in Norfolk more than in any other county in England; the cause of this greater prevalence is not, however, ascertained; whereas, according to Soemmering, these affections are unknown in some situations bordering on the Rhine. Liebig is of opinion that the exemption of the inhabitants of the countries bordering on the Rhine from calculus and gout, arises from the character of the Rhine wines, as containing a large quantity of tartar. The use of many kinds of wine unquestionably is favourable to the development of the uric acid diathesis; but, according to Liebig, the bi-tartrate of potash, which is abundant in the Rhine wines, being changed to the carbonate of potash in the progress of digestion, acts the part of an alkali, and secures the inhabitants against the deposition of uric acid.

There is not any body to which the elements of a calculus are more easily united than to a calculus itself. Whence, if a small stone formed in the kidney should descend through the ureter into the bladder, unless it be soon voided, it will in a short time increase in bulk by the slow apposition of fresh calculous particles; for which reason the renal stone is most frequently the basis of one in the bladder, and Denys declares that all whom he had cut for the stone, had first felt symptoms of it in the kidneys. It has sometimes been attempted to draw a distinction between calculi formed on a nucleus derived from the ordinary chemical constituents of the urine, and those which form by incrustation on foreign substances. Among the authors who have most insisted on this distinction is Von Walther. His view, however, is somewhat peculiar, and he makes several assumptions which are hardly conceded to him by those who have commented on his treatise. He regards urinary calculi as holding a middle place between crystals of a purely chemical character and organic growths; partaking, as he says, more largely of the latter character than of the former. He considers deposits thrown down from the urine owing to its mere saturation, to form solely sand and gravel; and that true calculous concretions do not form except when there occurs a certain degree of inflammatory action in the urinary passages, and a peculiar chemical change in the constituents of the urine which enter into them. Thus, he affirms that the oxydation of uric acid is a necessary preliminary to its transition into a true calculus; and that the secretion from the lining membrane of the urinary passages is also requisite to form an agglutinating matter. Further, he assumes that the successive oxydation of the uric acid is accompanied with a relative want of oxygen, and that an excess of azote determines to the formation of the uric acid calculi; while a defect of azote determines to the formation of the oxalate of lime concretion. He informs us that ammoniaco-magnesian phosphate is the only one of the ordinary constituents of calculi which exhibits signs of crystallization; and he ascribes this and the deposition of phosphate of lime, which commonly occurs on the outer surface of calculi, to their being simply chemical deposits from the urine, determined by the previous presence of solid bodies in the bladder. Thus these phosphatic concretions approach, according to him, to the character of simple incrustations, such, as he says, take place on foreign bodies. It is a part of this view, then, that while ordinary calculi participate in the character of organic growths, incrustations such as those referred to are simply chemical deposits.

The objections to these views arise from their hypothetical character. Wetzlar strongly controverts these opinions, affirming that urinary calculi are in one respect organic bodies, and that the supposed changes in the uric acid, and in the membrane of the urinary passages are entirely hypothetical. Wetzlar, however, has gone perhaps into the opposite extreme; he maintains that the free state of uric acid in the urine is unnatural, conceiving that in its ordinary state it exists combined with soda, thus adopting a view akin to that of Prout, when he taught that uric acid is retained in solution by being combined with ammonia. Wetzlar, following up this idea, attempts to show that the presence of lactic acid in the urine is not incompatible with the existence of urate of soda in solution;

but that as soon as this urate of soda meets with a stronger acid, the decomposition takes place, and the insoluble uric acid concretes.

It had long been believed by medical authorities of the highest estimation, even before the chemistry of calculous concretions was understood, that acids and acescents were among the most active causes of gravel; and since chemistry has afforded a still more exact and intimate knowledge of all the sources of this disease, pathologists have been able to trace a new and more hidden cause of urinary concretions in acidity generated in the alimentary canal from a morbid condition of the digestion.* It is to this latter source that uric acid has been traced; and all know how large a share this has in the composition of stones in the bladder. It is true that this view has often of late been controverted by chemical authorities; but among practical writers there is hardly any opinion in regard to urinary calculi on which there is so complete an agreement. To this cause, namely to the use of acescent wines in France, and of malt liquor in Britain, the prevalence of calculi has often been ascribed; and it is even alleged, on something like authority, that calculous complaints have been much less frequent in England since the time when hops began to be largely added to beer. Among recent authors Magendie is one of the strongest supporters of the effect of acid in the production of urinary concretions, insisting, at the same time, as before remarked, on the effect, or the concurrent effect of a rich animal diet. Mr. Crosse, of Norwich, is also among the recent writers who considered the prevailing source of urinary calculi to be dyspepsia, leading to the generation of acid in the stomach, and to the superabundance of uric acid in the urine. He, however, is against ascribing the origin of urinary concretions to any one cause, expressing his opinion that neither the food, the soil, nor the beverage, used by the inhabitants of Norfolk, has great effect in producing the tendency to calculous complaints in that county; and he is inclined to ascribe some part at least of this tendency to the variableness of the climate of Norfolk, and to the prevalence, as he says, of north-east winds. Mr. Crosse illustrates this, by stating that he has known persons quite free from any calculous tendency come from London to Norfolk to reside for a few weeks, and during that period contract a disposition to the disease.

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* "Wherever," says that accurate pathologist, Murray Forbes, "fermented liquors are a common beverage, stone and gravel have been observed to be more than usually frequent."

Dr. Wilson Philip has thrown the result of his observations on the origin of calculous complaints into a few distinct propositions, which deserve to be quoted, though in some respects they are at variance with the views which have been more recently taught on this subject.

1. That rancid and acescent ingesta tend to increase the deposition of uric acid from the urine, and to prevent that of the phosphates.

2. That a diet composed of a large proportion of animal food tends to lessen the deposition of uric acid, and to increase that of the phosphates.

3. That everything which promotes the action of the skin tends to prevent the deposition of uric acid, and to occasion that of the phosphates.

4. That dyspepsia tends to increase the deposition of uric acid, and to lessen that of the phosphates, both by producing acidity of the primæ viæ, and by rendering the skin inactive.

5. That indolence has the same tendency both by inducing dyspepsia, and by lessening the activity of the skin, in proportion as it impairs the vigour of the circulation.

6. That an acid passes by insensible as well as sensible perspiration.

As respects the first of these propositions, as has been already remarked, most practical writers are fully agreed. As to the second, it has been seen that Magendie states a totally opposite view. He says, that when animals live altogether on flesh their urine is full of uric acid, and even may be entirely composed of it, as is proved with respect to birds, by the experiments both of Dr. Wollaston and Vanquelin. On the contrary, if animals live on vegetables, as is the case with the herbivorous class, that there is no appearance of uric acid in their urine. In a series of experiments communicated by Magendie to the Academy of Sciences, in 1816, it is reported that if a carnivorous animal be deprived of all nutriment containing azote, and be fed with sugar, gum, oil, and other substances considered to be nutritious, though they have no azote in their composition, the urine in three or four weeks will contain no uric acid. The inference which Magendie draws from his experiments, and from some cases which he has detailed, is, that the quantity of uric acid in the urine, and of course the tendency to gravel and calculous disorders, depends very much on the kind of food. However, he takes into consideration the relative proportion of the uric acid to the urine itself, because if this be also abundant, the liability to calculi is counteracted. It would appear also from his observations, that the urine is not only impregnated with a large proportion of uric acid in animals which eat a large quantity of flesh, but is also scanty ; and that, on the other hand, a vegetable diet always promotes the secretion of a large quantity of fluid from the kidneys, as well as checks the formation of the acid in question. Magendie is also disposed to believe that the rarity of calculi in hot climates may be partly traced to the kind of food employed. In fact, it is well known that in a considerable part of Asia, many millions of the inhabitants never eat flesh. Thus these views may be allowed to have full weight, with respect to the sects which religiously decline animal food; but the influence of climate cannot be rejected, because calculi are rare in all hot countries, whether meat be freely eaten or not. At the same time, the general tenor of this reasoning may be true, that the influence of climate and vegetable diet tends to prevent the formation of uric acid calculi, while large quantities of such food as contains a great deal of azote has the opposite effect. (*Cooper's Surgical Dictionary, Urinary Calculi*, p. 1345.) With respect to the third proposition, there is good reason to think that it is essentially correct. It has long been remarked, that when the action of the skin is defective, there is a tendency to the deposition of red sand in the urine. And it has commonly been supposed either that uric acid is secreted by the skin when the perspiration is copious, or else that some other chemical compounds are thrown forth by that change, the formation of which renders the excretion of uric acid from the living system unnecessary. It is of frequent observation among practical writers, that when perspiration becomes unduly great it acquires an urinous smell. It is equally a remark of practical writers, that when perspiration is kept up to great excess for a number of hours, that the deposit in urine consists of phosphates. For example, after such exercise as dancing for many hours, there is often a white deposit in the urine. This kind of deposit under such circumstances is exactly what we should expect in accordance with Liebig's views.

Violent exertion of the muscular system, such as long continued dancing must cause an unusual disintegration of the muscular tissues; but since this disintegration is connected with great activity of the respiration, and therefore with a full supply of oxygen, the product will rather be an abundance of urea than of uric acid. In short, it may be readily conceived, on Liebig's principles, that the proportion of uric acid to the urea, in such a case, is much less than under ordinary exercise. At the same time a large disintegration of the muscular tissues cannot take place without a considerable proportion of phosphates being set free, and mingled with venous blood, from which, after it has passed through the lungs, they are finally separated by the kidney. What Magendie says on this subject is, that excessive perspiration, by diminishing the amount of blood in the urinary secretion, produces a relative superabundance of uric acid, so as to become a cause of the uric acid concretion. It seems possible that when excessive perspiration is unaccompanied with muscular exertion, and increased activity of the respiration, what Magendie says may be correct, thus affording a limitation to the proposition just cited from Wilson Philip's paper. With respect to the fourth proposition, no further remark need be made upon it, after what has been said above, neither do the two subsequent propositions require any further observation.

Under the head of the causes of urinary concretions, it would be improper to omit some notice of the remarkable view taken on this subject by Mr. Copland Hutchison. The purpose of Mr. Hutchison's paper is to show, that sailors and seafaring people enjoy an extraordinary degree of exemption from calculous complaints. He estimated the number of seamen received as patients into the great naval hospitals during sixteen years; and out of 86,000 patients he found that there had been no more than eight cases of calculus. He also made particular inquiries at the great hospitals of England, and found that the exemption from calculus was as great in the mercantile navy as in ships of war. Mr. Hutchison has certainly succeeded in showing that calculus is not a disease to which seamen are particularly subject. Doubts, however, have been entertained, as to whether the data on which he proceeds are sufficient to show that they possess a special exemption from this disease. Sir George Ballingall has made it appear that soldiers enjoy a similar exemption. On this point Mr. Samuel Cooper remarks: "Mr. R. Smith, of Bristol, has published an interesting statistical inquiry into the frequency of stone in the bladder in Great Britain and Ireland, though strictly it is a comparative estimate of the number of operations for stone in different parts of the kingdom in given spaces of time, and in all the number of calculous patients. So far as I can judge from the facts stated in Mr. Smith's paper, and from what I know about the average number of operations for stone in London, not more than 180 can be fairly reckoned as the annual total of Great Britain and Ireland, which is about one for each 100,000 of the population taken at 18,000,000. Now, if this fact be recollected, in reasoning about the rarity of stone operations in the navy, and the other circumstances, of their being few children and old men in that service, and of every man being examined by a surgeon as to the state of his health before he is entered, I think the reason of the unfrequency of the stone in the navy will be tolerably clear. However, as sailors live partly in very hot, and partly in very cold climates, even if they were of the ages most subject to calculi, they may perhaps be rather less disposed to the complaint than those individuals of the same periods of life constantly resident in England. In the cold country of Sweden, urinary calculi are said to be unfrequent; and as surgery is there highly cultivated, the statement weighs considerably in favour of the truth of the general belief of the rarity of this disorder in very cold countries; but, as I have already said, the number of inhabitants to which any particular evidence on this point relates, is an essential inquiry, before a safe inference can be drawn." Notwithstanding these objections, Mr. Hutchison's paper must be regarded as a valuable contribution to the medical history of calculous complaints; for though seamen may not be more exempt than some other classes of the community from this disorder, it is at least satisfactory to know that so very large a body of men, living in a special manner, and on a special kind of diet, should enjoy an almost complete exemption from this malady; the more so, because the ordinary diet of seamen cannot be regarded as particularly favourable to the healthy exercise of the organs of assimilation. The most striking peculiarities of a seafaring life, in the British Navy, particularly at the time when Copland Hutchison wrote, are, first, that the men live very largely on animal diet with bread, but without fresh vegetables; that they have few opportunities of drinking wine or malt liquor; that diluted spirits constitute their daily drink; that they pass their lives freely exposed to the atmosphere, and therefore exercise the functions of respiration with an unusual vigour; and, above all, that they seldom retain the urine in the bladder after the first call. It may be added, that Mr. Copland Hutchison thinks that some part of the exemption which they enjoy may be due to the copious perspiration produced in the sailors on board ships of war, owing to the narrow space into which their hammocks are crowded during the night.

Van Swieten (*Comm. on Aph.*, 1414) gives a very lucid account of the origin and growth of calculi. "Stones," he says, "proceed from elementary principles, which, under the appearance of fluid, previously existed in the humours, and when these meet with an indissoluble basis, they fix themselves thereto, and form a calculus which continually increases in bulk from the application of fresh calculous matter."

Cheselden, in his "Anatomy of the Human Body," notes two extraordinary calculi found in the bladder; one was cut out from the bladder of a soldier, in St. Thomas' Hospital, the nucleus of which consisted of a bullet that had been discharged from a musket, and lodged in the bladder; the other was extracted from a boy five years of age, in the centre of which was discovered a needle. The celebrated Nuck (*Adenograph. Curios.*, p. 80) demonstrated the above fact by an experiment; having opened the abdomen of a live dog, he drew the bladder out of the wound, and made an incision in the fundus with a sharp knife; through this wound he introduced a little round wooden button, and as soon as the fibres were in a state of contraction, he replaced the bladder in its natural situation, and sewed up the wound. The animal for the first two days seemed dull and sick, but in a little time the natural appetite and alacrity returned, and the only uneasiness observed was a more frequent inclination to make water than usual. Some weeks after he dissected the dog in his private theatre, and the button being extracted, appeared covered over with a calculous crust. We have already incidentally noticed the distinction which Van Walther has attempted to draw between true urinary calculi and incrustations by chemical deposit from the urine. It does not appear, however, that the structure of these incrustations has yet been sufficiently examined to entitle us to say that there is any just ground for distinguishing them into two orders of concretions. Many physicians, Hippocrates tells us, believed that when they thus saw sand in the urine, there was a stone in the bladder; but this he contradicts. Neither can we always depend on the character of the sediment as affording a certain indication of the constitution of the stone.

Dr. Wells (*Transactions of a Society for the Improvement of Med. and Chir. Knowledge,* vol. iii. p. 192) gives the case of a man in whom sounding detected the presence of a calculus, and his urine deposited a "white powdery sediment." "This," he adds, "I examined, and found to consist of the urate of ammonia." The patient eventually died, when analysis showed, "the whole of the calculus, except the nucleus, was composed of triple phosphate of magnesia and ammonia. The nucleus, which was very small, consisted of uric acid."

It may be supposed that the concretions which occur elsewhere in the living system, might throw some light on the generation of urinary calculi. Such concretions not unfrequently assume the same rounded form with urinary calculi, but there is little agreement with them in their composition. The tophi, or chalk stones, which form on the joints of gouty persons, are the only concretions elsewhere in the body which distinctly participate in the same kind of character as urinary calculi. These concretions contain uric acid, and consist in general of urate of soda.

The concretions assuming the form of urinary calculi in other parts of the body are calcareous, and for the most part consist of phosphate of lime. Such calcareous dep[illegible]ve been found in the heart. Hottinger relates a case in the *German: Ephem:* in which a congeries of whitish stones were found in the right ventricle of the heart of a man who had died of dropsy. Bonetus (*Sepulcretum*, l. ii. s. 8, obs. 15) cites a case in which these calculi were found in an enlarged heart of a youth who, when alive, was troubled with so loud a palpitation as to be audible to bystanders. There is also in the *Phil. Trans.* for 1665, the case of Lord Balcarras, in whom calculi were discovered towards the base of the heart, between the right and left ventricles.

Singular as it is that stones should be found in the heart, it seems no less so that they should be found in the blood-vessels ; and yet this has happened. Cheselden, in his Anatomy (fig 30), delineates two calculi which were taken from the origin of the aorta. Hoffmann (in *Mantissa Obs. Select.*) relates the case of a Batavian nobleman who was afflicted with a most obstinate pain for which he could get no relief. On opening the body after death, the kidneys were found quite sound, and without calculi ; but at the bifurcation of the aorta, six calculi presented themselves.

Greiselius relates that on opening a vein in the arm of a man seventy-two years of age, who was troubled with catarrh, four stones passed with the blood into the basin ; and Bettus, in the appendix to his work on the nature of blood, mentions a similar occurrence from a vein on the external ankle. The concretions described by these two authors appear to be of the same nature as the bodies which have of late been termed phlebolites. They are described by Beclard, in his Anatomie Generale, in the chapter on veins, and by Jules Cloquet in his Pathologie Chirurgicale ; and they have subsequently been noticed in this country by Dr. John Reid. According to the last-named author they are not of rare occurrence. He had seen them in five instances, four of which occurred within one year in subjects brought to the dissecting room. In three of these they were found in the uterine veins; in a fourth both in the vesical and uterine veins; and in one male, in the vesical veins. According to Cloquet and Beclard they have been found in the hæmorrhoidal and spermatic veins of the male, in the saphenæ veins, and in the vena cava inferior. In Dr. Reid's cases these bodies varied in size from that of a millet seed to that of a large pea, and in number from two to more than a dozen. In all the cases in which he examined them they seemed to be placed loose in dilatations of the veins, allowing sufficient space for the blood to pass between them and the coats of the vessels. The subjects in which he found them were all advanced beyond the middle period of life. Beclard and Cloquet described them as being most frequently enclosed in layers of fibrinous matter or coagulated blood; but in all Dr. Reid's cases except one, he found them without any covering whatever, while nearly all of them were of a bony hardness throughout. No very perfect analysis of these bodies appears as yet to have been made. Phosphate of lime, however, and also carbonate of lime, together with some animal matter, have been detected in them. These bodies appear to be formed by a deposition from the blood on a plan analagous to that on which urinary concretions are produced.

If, as we have seen, calculi are formed in the cavities of the heart and uterus, we cannot be surprised to find them also in other viscera: indeed no organ can be said to be exempt from such morbid depositions. They are found in the lungs, whence they are frequently expectorated; in the thymus gland, the liver, spleen, and pancreas, and in the mesentery. Valentine relates a singular case of a calculus—preserved in the museum at Frankfort—being met with in one of the vesiculæ seminales. Not less rare and curious is the generation of calculi in the uterus; and yet Hippocrates mentioned this fact in his book, De Morbis Popularibus; these calculi Ramazzini very ingeniously conjectures had found their way by passing from the urethra into the womb.

Calculi have been found in the brain, especially in oxen. Berthol gives an instance wherein the surface of both the cerebrum and cerebellum was converted into a substance as hard as a stone. Stones have been found in the substance of the optic nerves. The pineal gland is well known as a common seat of calcareous deposition.* Des Cartes imagined this gland to be the seat of the soul; however, the case related in the Philosophical Transactions for 1686, in which this gland was found petrified in a distinguished literary character, was a death-blow to such an absurd hypothesis.

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* De Graaf (De Succ. Pancr. p. 113) relates that he had seen stones in the pineal gland above twenty times, in persons who died both by natural and violent deaths.

CHAPTER XVI.

SYMPTOMS OF STONE IN THE BLADDER.

MAN is not the only animal subject to urinary calculi; in the higher mammalia we often notice that their formation, passage into the bladder, and gradual increase in size, are attended by the same train of symptoms as those with which we are familiar in our own species. The Museum of the Royal College of Surgeons contains specimens from the monkey, dog, rat, rabbit, hog, horse, ass, ox, sheep, elephant, whale, eagle, ostrich, fowl, tortoise, iguana, and sturgeon. Several of these specimens, however, are unauthenticated, and others are ascribed to animals in which it is scarcely possible they could have occurred. The collection shows that graminivorous animals are more liable to calculous disorders than carnivorous; and also that calculi from the lower vertebrata consist in greater part of carbonate of lime. In the private cabinet of Dr. Gross,* of Louisville, U. S., there

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* A practical treatise on the "Diseases and Injuries of the Urinary Bladder, the Prostate Gland, and the Urethra," by S. D. Gross, M.D., Philadelphia, 1851.

This book came into my hands at the time I was engaged on is a beautiful specimen from the bladder of the hog; it is of a whitish colour, of a rounded, oblong shape, very rough on the surface, and weighs eight ounces. Professor Cobb has a magnificent calculus taken from the bladder of a dog. "Rats and mice," observes Dr. Gross, "are said to be particularly subject to urinary calculi, and the disease is also met with in the cat and the rabbit." In the former animal I have met with two instances of this affection; in neither, however, was the presence of a calculus suspected, the animals being both destroyed in consequence of their becoming mischievous, irritable, and emaciated. Professor Silliman has a calculus taken from a whale. It follows, therefore, that being in a perfectly natural state, and partaking of the simplest kind of food, does not render the animal frame exempt from calculous affections.

Coloured people seem rarely to suffer from calculous complaints. During a residence of ten years in Kentucky, Dr. Gross does not recollect to have met with a solitary example of gravel or stone in a coloured person. Dr. Dudley, who enjoys one of the largest practices in that part of the world, has never cut more than two or three of these people, who are constantly exposed to hard labour, and fare often upon the coarsest food. The disease is rare in Canada, in Texas, Mexico, and California. In the United States, a larger number of children are affected with this disorder in Kentucky, Ohio, Tennessee, and Alabama, than in any

this chapter, and I only regret that I had not the good fortune to see it earlier: it is a work deserving the attentive perusal of all who take an interest in these diseases.

other region. The inhabitants of Missouri, Iowa, Wisconsin, Michigan, Indiana, New York, and New Jersey, are comparatively exempt. I have mentioned these facts upon the authority of Dr. Gross, because they confirm that which has been so long observed in this part of the world, namely, that calculous disorders are much more prevalent, from causes hitherto wholly unexplained, in some districts than in others. The county of Norfolk has long had a character of this kind; and many surgeons, among whom I may mention the late Mr. Crosse, have enjoyed a high reputation for operative skill and success in lithotomy, acquired through the numerous cases which came before them.

Stone in the bladder may exist at all periods of life. It has been described in some rare instances as an intrà-uterine affection. Geyer (*Miscel. Nat. Curios.*, Dec. II., An. V., p. 450) has recorded the case of a boy who suffered from calculus from birth; he was cut in his twelfth year, when the stone had acquired so large a bulk, that it had to be broken before it could be extracted. The whole mass weighed ten ounces. Stahl found a calculus the size of a peach-kernel in an infant of three weeks, who had from its birth suffered great distress in passing water. I have upon many occasions extracted calculi from children under three years of age. My youngest case was a boy of eighteen months. The oldest patient upon whom I have operated was eighty years of age.

Of 5,376 cases mentioned by Civiale, in his "Treatise on Calculous Affections," (*Diss. de Morbo Fœtuum in Uteri Materno*, s. 6,) 2,416 were children, 2,167 adults, and 793 old persons; 1,946 occurred before the age of ten, 943 from ten to twenty, 460 from twenty to thirty, 330 from thirty to forty, 391 from forty to fifty, 513 from fifty to sixty, 577 from sixty to seventy, 199 from seventy to eighty, and 17 after eighty.

With the exception of some rare instances, in which the nucleus consists of a foreign body, urinary calculi are first formed in the kidney; while small they drop along the ureter into the bladder, where they increase by a succession of layers deposited from the urine. If smooth and small, the passage of the calculus down the ureter excites little or no inconvenience; it may remain even in the bladder a long time without the patient being aware of its presence. If, however, the renal calculus be rough, and of some size, its descent into the bladder is attended with most excruciating suffering—the pain extending from the back down the thighs, and along the course of the chord, being sufficient to "double the patient up," and make him roll in agony on the ground. The descent generally occupies from twelve to twenty-four hours. The usual symptoms in the milder cases are, nausea, rigors, restlessness, and some alarm; pain in the back, coming on more severely in paroxysms, and extending down the thighs; retraction of the testicles, coldness of the extremities, and extreme prostration.

The calculus may become impacted in the vesical orifice of the ureter; the flow of urine from the corresponding kidney will then be prevented; dilatation of the ureter and distension of the tubular structure of the kidney will ensue, terminating in absorption of its secreting surface; but most of the usual symptoms of stone in the bladder will be absent.

When a calculus is loose in the vesical cavity it falls to the most depending part behind the prostate; but it shifts about according to the posture of the patient, and gives rise to symptoms which are more or less marked in different cases.

In the earlier stages of stone in the bladder, while the organ is healthy, the patient experiences a dull sense of weight about the neck of this organ, with pain or uneasiness extending to the hypogastric region, perineum, groin, or thighs. The bladder becomes irritable and cannot retain its contents; the calls to make water are more frequent, and the expulsion of the last drops is attended with pain, which shoots along the perineum and penis, and centres in the glans. Sometimes when the urine is flowing in a full stream, it is suddenly stopped, evidently in consequence of the foreign body falling across the orifice of the urethra and mechanically obstructing it. The patient finds he cannot take any violent exercise without suffering pain; the jolting of a carriage is insupportable to him, and is frequently followed by a discharge of bloody urine, while in some constitutions, hæmorrhage to a considerable extent takes place. As the evil increases, micturition becomes more and more frequent and distressing; the pain following the act is very severe,—patients writhe with their bodies, and grind their teeth in agony. The last drops are expelled with cramp or spasm of the bladder which endures for some time, and the contents of the bladder and vesiculæ seminales are often involuntarily passed, adding materially to the distress and exhaustion of the patient.

There is occasionally priapism, with or without sexual desire.

These symptoms come on slowly; indeed, if the stone be smooth, and the bladder healthy, there may be nothing for a considerable time to direct the patient's attention to his case. Sooner or later, however, indications of disturbance of the urinary organs ensue, and the features of the affection become well marked.

The pain and sensation of weight about the neck of the bladder, is one of the earliest symptoms. It varies in character, being sharp and acute, as well as dull and heavy. It is described by some authors as sometimes periodical; and Deschamps (*Traité de la Taille*) relates the case of a man, in whom for upwards of eight months pain of a sharp cutting character, excited by this cause, came on at every return of the new moon. Although, as a general rule, the larger and the rougher the stone the more acute the pain, exceptions to this are occasionally met with. I removed from a thin man, of advanced age, an oval stone, which had never excited very severe suffering; and there had been great difficulty experienced in detecting its presence by the sound. I presume that in all these cases there is no congested or inflammatory condition of the bladder. When such a state ensues, the sufferings of the patient become greatly aggravated, and there are but few means which we possess of affording effectual relief. Dr. Gross thinks that a spiculated stone, or one studded with long spines, produces often very slight suffering, because the spines admit of the more ready passage of the urine, in the same manner that a very rough body lodged in the bronchial tube will occasionally cause less distress than a smooth body, as it produces less obstruction to the entrance of the air.

We generally find that in cases of phosphatic calculi there is more suffering than when the stone is composed of lithic or oxalic acid, because in the former, there is generally a morbid condition of the kidney, and of the urinary passages generally. If the patient be of a nervous and excitable temperament, or if he be of gouty or rheumatic habit, the pain experienced is often of an anomalous character, and is described by the patient in excited and exaggerated terms. The patient suffers the least, when, from some cause, the stone has become fixed; thus an impacted or encysted calculus may remain for years without giving any indication of its presence. If the prostate be enlarged, the bladder partially paralysed, and the power of emptying the organ in a considerable measure lost, the sufferings of the patient are far less intense than in a younger subject in whom no such changes have yet taken place. I have generally noticed that the feeling of weight about the neck of the bladder rarely passes away, and is often more complained of after violent exercise than when the patient has remained quiet in the recumbent posture. The frequent calls to micturate are a source of constant annoyance to the patient. Sometimes they occur every hour, or even every half hour. Should the calculus have caused ulceration of the mucous membrane of the bladder, the desire to make water becomes proportionably more severe, so as to be almost, if not wholly uncontrollable.

A moveable stone, falling across the orifice of the urethra suddenly arrests the flow of urine; I regard this symptom as almost pathognomonic, since it is scarcely ever produced by any other cause. The arrest in the flow of the urine does not endure more than a few minutes; it disappears upon some change of posture, or upon pressure in the hypogastric region. But if the calculus be so small, or of such a shape as to admit of becoming impacted in the urethra, the catheter is required to push it back, or even some more severe operation may be required, from the fact of its producing complete retention. Patients have been known in micturition to lie on the back, and to elevate the pelvis; the object being to allow the calculus to drop by its own weight from the urethral orifice.

Children who labour under stone, cry, and even scream, at the time of passing their urine, and especially afterwards; they constantly apply their hand to the end of the penis, and elongate the prepuce in their attempt to deaden the painful sensation which they experience.

It is common to remark, that in such cases the hand is frequently kept upon the penis; and children have been corrected for a habit which, to the eye of the surgeon, clearly announced the existence of this very serious affection. In adults, erections of the penis and involuntary emissions of semen add to the existing discomfort. The jolting of a carriage commonly produces bloody urine; and a patient obliged to ride much on horseback would notice the existence of hæmaturia at an early stage of the complaint. This discoloration of the urine may last several days; but it generally disappears with rest and the recumbent posture. When there is ulceration of the bladder the case becomes complicated, and the hæmorrhage is more profuse; but I do not believe that in these cases the blood flows, as a rule, from any other part than the mucous lining of the bladder.

Severe exercise and indiscretions of diet often produce a disharge of mucus, and the quantity is greatest in aged subjects, in whom the bladder has become thickened and diseased. The colour of the mucus is greyish, or greyish-yellow; it is stringy or ropy; more or less fœtid, and forms a dense, tough, yellow layer at the bottom of the vessel in which the urine is voided. If it be raised with a bit of wood, it adheres, and drops slowly down in a continuous gummy stream.

Prolapsus of the rectum, especially in young children and old men, is by no means an uncommon complication. Its degree varies considerably; but it is at all times a source of great inconvenience, because it is so frequently attended with the discharge of flatus or the fæces.

When a urinary vesical calculus has existed for years, and has brought on severe symptoms, more especially if complicated with stricture of the urethra or enlarged prostate gland, the kidneys, though before healthy, become involved; the severe dysury causes enlargement of the ureters from distension by the retained urine, and inflammation extends along them, even to the kidneys themselves. The pelvic cavities become altered in shape and enlarged, the infundibula are extended or unfolded, and the lining membrane of the cavities, thus acted upon, becomes thickened from repeated attacks of inflammation, and contributes to furnish the catarrhal secretion. The parenchymatous substance of the kidney is next more or less absorbed ; the mammary projections are obliterated ; cysts, formed of dilated uriniferous tubules, occupy the cortical part ; and all the most serious evils that belong to renal affections,—ulceration, contiguous abscess, or gangrene,—follow in the train, and carry off the victim.

There is a look of great distress in a patient suffering constitutionally from the presence of a stone in the bladder. He is anxious; the brows are partially contracted and expressive of suffering, both bodily and mentally. He becomes thin and wan ; the skin is dry; the extremities are cold ; the pulse small ; the stomach does not readily receive food ; the secretions are vitiated, and the bowels become irregular and irritable. Pains may manifest themselves in parts of the body quite removed from the seat of disease, such as the knee, heel, foot, or arm. Then come on night-sweats and colliquative diarrhœa, and the sufferer sinks from exhaustion. Many circumstances may give temporary remission of the symptoms, and there is always the possibility of the stone becoming encysted. Cases, too, are recorded, and quoted in another part of this work, where calculi have existed for years in the bladder without giving rise to any symptoms, and have been discovered for the first time upon examination after death. In the majority of cases, however, irritability of the bladder and pain after passing the urine are the only symptoms, especially in the early stage, which distress the patient.

Persons affected with stone, and at the same time subject to gout, (which is by no means an unfrequent coincidence,) require the greatest care as regards an operation proposed for their relief; for any increase of irritation may bring on an attack of gout, in which the bladder sometimes participates. It is in such cases as these that operations must be promptly performed; for useless and long-continued manipulations are apt to to be followed by serious results.

Patients with diseased and enlarged prostate are said not to suffer more than others from stone in the bladder; probably in consequence of the tumour of the prostate preventing the stone falling down on the neck of the bladder.

A variety of affections involving the neck of the bladder may cause pain and uneasiness in the hypogastric region and thighs; and the flow of urine may be suddenly arrested by a pedunculated tumour falling across the urethral aperture. Blood may be mixed with urine from the vessels of a malignant growth, or from the mucous membrane of the bladder or urethra in many other complaints than stone. When the bladder is inflamed, it is intolerant of urine, and pain is experienced after the expulsion of the last drops. It must, therefore, be laid down as a rule, that we cannot positively pronounce upon the presence of a calculus in the bladder unless it be ascertained by the sound; and there are few operations which differ more in the suffering which they cause to the patient by the manner in which they are performed, than this apparently simple proceeding.

Sounding.—The solid steel instrument called a sound is smaller than a full-sized catheter, resembling it in shape, but with a shorter curve, so that it may be more freely moved within the vesical cavity. It should be well polished, about twelve inches long, with a broad flat handle; a proportionately smaller instrument being required for children. The curve should form an angle of 45° with the straight portion, and not exceed three inches; the extremity should be smooth and well rounded, that it may not injure the mucous membrane of the bladder, or catch in any of the urethral follicles. But the operator should possess sounds of different curves; for general use, that is to be preferred which possesses a short curve, and admits of free movement in the bladder. No surgeon in the present day would think of using the ordinary silver catheter for the purposes of sounding. The instrument is wholly unfit to convey the proper sensation or sound.

Previous to sounding, the bowels should be opened by an enema. If the rectum be distended, it occupies too much of the pelvic cavity, and prevents a satisfactory examination being made per anum, should the case require it.

Care should be taken that the bladder be not empty: the organ would then contract upon the sound, or, in any circumstance, impede its movements so much that the stone might escape the point of the instrument. Warm water can always be injected into the bladder, if it be necessary, and about four to five ounces will amply suffice for the purpose.

The patient having been placed in the semi-recumbent position, the instrument, previously well oiled, should be passed carefully and gently along the urethra into the bladder, the cavity of which is then to be explored. First, the handle should be slightly raised and the convexity of the sound passed in a sweeping direction from before backwards, along the inferior surface of the bladder from the neck to the fundus. Next, the bladder should be explored laterally by revolving the handle from side to side between the fingers and thumb. Lastly, the instrument is to be withdrawn to the neck of the bladder, and the point is to be directed first downwards to the space behind the prostate, and secondly upwards to the surface behind the pubes. If the bladder be suddenly emptied during the operation, we may withdraw the sound, and slowly inject through a catheter a moderate quantity of warm water by means of a properly adapted syringe or elastic gum bottle. The patient should be supported on a table or sofa so as to enable us to depress the shoulders and bring the fundus of the bladder to a depending position, into which the stone may gravitate. Sounding a patient is an operation which cannot be satisfactorily performed in a hurry; and it may be necessary to repeat the proceeding several times before we can form a positive opinion on the presence of stone or not. It may excite in some patients such severe suffering that it becomes advisable to exhibit chloroform, which, by producing insensibility, greatly facilitates the operation.

A hard stone, as the oxalate of lime or the lithic acid calculus, rings when struck, and communicates th the instrument a peculiar sensation. A soft calculus, composed of the phosphates, conveys a more equivocal feeling to the operator; the instrument strikes against a hard unyielding substance, but the sound is less sharp, or almost inaudible. The size may be partly guessed by marking the extent of hard surface over which the sound passes, and the readiness with which the calculus is found in all conditions of the bladder. But considerable experience is requisite to form an accurate opinion upon the subject, unless we choose to introduce the instrument used in lithotrity, in which the amount of separation of the blades is indicated by a graduated scale on the handle. The stone may thus, if requisite, be measured in every direction; but, for my part, I think it, as a general rule, a very unnecessary proceeding, and subject to the risk of breaking the calculus. The larger and harder the stone, the more audible in general the sound communicated by the instrument. It is quite different from the grating sensation indicative of a fasciculated condition of the bladder, and may often be heard at the distance of several yards. The introduction of the finger into the rectum for the purpose of lifting the surface of the bladder behind the prostate, though very often practised, is requisite chiefly in old persons.

Sounding is an operation not wholly free from danger. It may produce acute inflammation of the bladder, than which no more formidable affection exists. Mr. Fletcher (*Medico-Chirurgical Notes and Illustrations*) relates the following case:—A healthy boy, six years old, was brought to the hospital with symptoms of stone, for which he was twice sounded by the surgeon, who satisfied himself on both occasions of the existence of the disease. On the day, however, appointed for the operation, he could not detect it, and several of his friends tried successively with no better success. The surgeon at length put a stop to these proceedings; but his interference was too late. The boy was put to bed, complaining that his belly ached. Active peritoneal inflammation followed; and, notwithstanding the most energetic means to control it, death took place on the fourth day after sounding. The inner membrane of the bladder was spotted deep red everywhere, and its peritoneal coat was glued to that of the intestines, which were on all sides inflamed and covered with lymph.

Dr. Gross sounded a young man, in 1844, who had suffered for twenty-four years from stone in the bladder, attended with chronic cystitis, and great disorder of the general health. The operation was performed with all possible gentleness, and yet three weeks elapsed before he was sufficiently recovered to justify the performance of lithotomy. Severe cystitis ensued, accompanied with violent spasm of the bladder, and the bowels became tympanitic and exceedingly tender on pressure, evincing existence of peritonitis. These symptoms gradually yielded to the ordinary antiphlogistic remedies, but not without inducing the belief at one period that the patient would perish. Sanson, Civiale, Crosse, and others, have recorded similar, and even fatal cases. "In consequence," says Mr. Crosse, "of persevering and unsuccessful attempts to discover a stone with the sound in a little boy, inflammation of the bladder came on, attended by vomiting, and extending to the peritoneum; the most antiphlogistic treatment failed to arrest it, and death ensued in four days."

The practice of auscultation, by applying a stethoscope to the pubic region, the sacrum, or the perineum, as recommended by Laennec, is not adopted by modern surgeons, for the unassisted ear can detect, if possessed of its proper power, the contact of the steel instrument and the stone. It has been recommended by Dr. Ashmead, of Philadelphia, to distend the bladder, in doubtful cases, with air introduced by a proper syringe, after the withdrawal of the urine, the former fluid being a better conductor of sound than the latter. The proposal, ingenious as it is, has not met with encouragement. Before the operation of lithotomy be commenced the presence of the stone should be established upon the most unequivocal evidence, and that can be only obtained by the process of sounding, as commonly performed.

In a former publication I alluded to the difficulty which surgeons often experience in determining on the presence of stone in the bladder. Numerous instances are on record of large stones being found after death, the existence of which could never be verified during life by the most careful examination. As an instance of a stone being present, and yet not detected by the sound, I may mention the following case, quoted from Dr. Gross's work on Diseases of the Urinary Organs:—"Mr. Harding, an elderly gentleman, of Philadelphia, and a captain in the merchants' service, had laboured for several years under all the usual symptoms of stone in the bladder. As he made frequent voyages to Liverpool, he determined on one of these occasions to visit London, for the purpose of submitting his case to Mr. (now Sir Benjamin) Brodie. A most thorough exploration of the bladder was made by this gentleman, so distinguished for his knowledge of urinary diseases; but no stone was found. Upon his return to America, Captain Harding lost no time in consulting the late Dr. Physick, who lived within one hundred miles of his own residence. A calculus, of considerable size, was promptly detected by the sound, and in a few days removed by the lateral operation." These facts, observes Dr. Gross, were communicated to me, upwards of twenty years ago, by Captain Harding himself, who was a very respectable and intelligent man.

Some time ago I saw a gentleman who had been sounded by an experienced surgeon, who was unable to say whether or not there was a stone in the bladder; the examination caused a good deal of pain, and was never repeated. Sixteen months after the patient died, and a stone was found in the bladder weighing four ounces and a half, too large, as we may fairly suppose, to have formed since the sounding; the bladder was rather small, and the prostate not enlarged. I have been informed that the largest calculus in the museum of St. Bartholomew's Hospital was taken from a patient who was often sounded, but in whom the presence of stone could never during life be ascertained, although there was little or no doubt in the mind of the surgeon of its existence. In the Museum of the Royal College of Surgeons, there is a bladder taken from the body of a man, who committed suicide after long and unalleviated suffering from stone, the presence of which had never been detected, though he was repeatedly sounded by the late Mr. Abernethy and others. The bladder contains a large rough calculus, of an oval form, which measures in its several diameters about $1\frac{3}{4}$, $1\frac{1}{2}$, and 1 inch. The mucous membrane is thickened, indurated, and superficially ulcerated. The muscular and cellular coats also are thickened, and the peritoneum and other tissues round the bladder appear condensed and unnaturally adherent. The ureters are dilated and thickened ; both the bladder and prostate are of ordinary size.

Repeated examinations of the bladder with the catheter, observes M. Civiale,* have failed even in the hands of the most experienced surgeons, such as Cheselden, Pelletan, and Dupuytren, to determine the existence of stone. Verzascha,† Benevoli,‡ Duretus,§, Riverius,|| Marcellus Donatus,¶ Chesneau,** Valentin,††

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* Traité de l'Affection Calculeuse, p. 477. Paris, 1838.

† Obs. 52, p. 109.

‡ Dans. Masotti, loc. cit. p. 31.

§ Schol. in J. Hotten de Marb. Int. lib. i. c. 46, p. 143. On trouva après la mort deux pierres pesant chacune deux onces.

|| Praxis Med. i. 14, c. ii. p. 179.

¶ De Medic. Hist. Mirab. 1, 4, c. xxx. p. 453. A la mort du malade on decouvrit dans la vessie une grosse pièrre.

** Obs. 1, 3, c. x. ; Obs. 2, p. 354. Un calcul gros comme un œuf d'oie fut trouvé après la mort du malade.

†† Chirurg. Med. Sec. iii. c. 7, sect. ix. p. 352.

Riolanus,[*] Margagni,[†] Covillard,[‡] Tolet,[§] Colot,[||] Marand,[¶] Descamps,[**] and Chopart,[††] state facts which prove that large calculi, of the size even of a hen's or duck's egg, nearly filling the bladder, have escaped the most minute and careful examination. Even where there are numerous calculi, they cannot always be detected. Colot is said to have sounded a man of sixty, and though unable to ascertain the existence of stone, operated on him, and extracted twenty-two calculi, which were hard, and of the size of a hazel-nut. Lapeyronie died of stone; his bladder contained a calculus weighing more than three ounces, which was not discovered during life, although he had been sounded several times. Portal and Distel also died of this affection, but in neither could the stone be detected with the sound until it was too late to operate. M. Kruger Hansen[‡‡] relates the case of a man who suffered for a long time from dysury, and in whom a stone could never be felt. After death a very large calculus, covered with small pointed elevations, was found in the bladder. M. Leroy[§§] also mentions similar instances.

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[*] Anthrop. 1, 2, c. xxviii. p. 150, Riolan cité a ce sujet le cas de Casaubon.

[†] De Ledibus, Ep. 42, art. 10.

[‡] Obs. Intro. Chirurg. p. 42.

[§] Traité de la Lithotomie, p. 77.

[||] Traité de l'Op. de la Taille, p. 167, 170, et 172.

[¶] Traité de la Taille, p. 276.

[**] Ibid. t. i. p. 254.

[††] Traité des Maladies des Voies Urin. t. i. p. 55.

[‡‡] Beitræge Mecklenb. Aerzte, t. i. p. 115 et 123.

[§§] De la Lithotripsie, p. 56.

Cases not unfrequently occur in which a stone is felt distinctly at one time, and not at another, although the examination is made by the same surgeon, and, as nearly as possible, under the same circumstances. Mr. Crosse, in his work (fig. 9, plate i.), "refers to two calculi found after death in a gentleman who was about to submit to lithotomy; but the stone, previously ascertained to be in the bladder, could not then be felt."

A boy, aged twelve years, was admitted into one of the metropolitan hospitals with symptoms of stone; on the first examination, a stone was felt, but when the boy was put on the table to be operated upon, the stone could not be detected. He was brought a second time for the same purpose, but no stone could be felt. The parents shortly after removed him from the hospital. Not long after, the boy was brought to the General Dispensary, and the circumstances of the case related by the parent. It was determined to prepare the boy for the operation of stone, and then sound him, so that in the event of a calculus being discovered the operation might at once be performed. On introducing a sound, the calculus was distinctly felt, and I removed a calculus, weighing a little more than a drachm. Two cases occurred to me in which considerable difficulty was felt by myself and others in detecting a stone in the bladder. One, a child three years old, had been taken to an hospital and examined three times, but no stone was detected. I saw the child afterwards and sounded it three times, allowing an interval of a month between each examination, and it was only on the third occasion that I detected the calculus. Just before operating, considerable difficulty was again experienced in feeling the stone ; and it was not until the finger was introduced into the rectum, and the neck of the bladder raised, that the stone could be felt. The operation was then performed, and a stone composed of lithate of ammonia, and weighing one drachm and six grains, was removed. It was situated in a pouch at the neck of the bladder, so that the finger, on entering the bladder, passed over the calculus towards the fundus. I have no doubt that if the finger had been introduced into the rectum when the child had been previously sounded, the stone would have been felt.

The other case was a boy five years old, in whom I distinctly felt a stone on the first examination ; but on repeating it a month afterwards I was unable to detect the calculus. The child was sounded by one of the most experienced lithotomists in the metropolis ; but, after a careful examination, he could not detect a stone. After waiting three months, I sounded the child again, and at the extremity of the sound, towards the fundus of the bladder, I felt the stone. The operation was then performed, and a mulberry calculus, weighing one drachm and forty-three grains, was removed. The operation revealed the cause of the difficulty : the bladder was very capacious for a child of his age, and the stone was situated at its fundus. I could not touch the stone, as in ordinary cases, with my finger, nor seize it with the forceps, until pressure had been made over the bladder, and the child's body raised.

In a case in which Sir B. Brodie operated, he could discern no stone when he first introduced his finger into the bladder ; at last he felt it on the anterior part of the bladder, behind the pubes. It was not lying loose in the cavity of the bladder, but evidently contained in a cyst, communicating with the bladder by a round opening. By means of a probe-pointed bistoury, he carefully dilated the orifice of the cyst, and then, introducing his finger, separated the membrane from the calculus until he was enabled to take hold of the stone with the forceps. It was not only encysted, but adhering also; for it was brought away with a portion of the membranous lining of the cyst closely attached to it. The boy recovered, and the calculus is preserved in his museum.

Cysts or pouches are sometimes formed by the protrusion of the mucous membrane between the muscular fibres of the bladder, into which calculi, that had been loose in the bladder, and could be easily recognised with a sound, find their way, and cannot afterwards be felt; or it may happen, that when such a pouch exists, the calculus may sometimes be contained in it, and at other times makes its escape into the bladder, a peculiarity which will readily account for a calculus being sometimes easily felt, and at other times not at all. Sir B. Brodie relates the following case illustrative of this condition of the bladder. "The case is, in many respects, remarkable. I discovered a stone in a gentleman's bladder; but he was advanced in years, and as, for the most part, he suffered very little inconvenience from the disease, he did not wish to go through any dangerous operation for the sake of obtaining relief; nor did I think it right, considering all the circumstances, to urge him to submit to it. He went on, in general suffering little or nothing. He was a convivial man, dining a great deal in society, as if he had no ailment. Every now and then, however, he was suddenly seized with the usual symptoms of stone in the bladder, and very severe ones too : he then sent to me. I kept him in the horizontal posture, prescribed him an opiate clyster, and in the course of a few days, sometimes sooner, sometimes later, the attack subsided ; he was again at his ease, and enabled to return to his usual habits. I had been occasionally in attendance on him for three or four years, when he was seized with a severe cold, which ended in a pleurisy, of which he died. On examining the body, I found the stone imbedded in a cyst near the fundus of the bladder. The cyst was formed, in this case, not by the protrusion of the mucous membrane between the muscular fibres, but by a dilatation of both tunics of the bladder, the muscular as well as the mucous. The stone was not so closely embraced by the cyst as to prevent it occasionally slipping out of it ; and I suspect that this actually happened, and that it was when the stone lay in the cyst that the patient was free from the usual symptoms of calculus, and that his sufferings took place when the stone escaped from it into the general cavity of the bladder." Again, the bladder may ulcerate, and the stone either wholly or partially escape.

The causes of the difficulty in detecting stone in the bladder may be arranged under the following heads :—

1. Enlargement of the prostate.
2. Fungous growths at the neck of the bladder.
3. Other morbid conditions of the bladder, as cysts, fungus, polypus, &c.

4. Certain peculiarities in the situation and size of the stone.*

When there is a fungous growth at the neck of the bladder, it must offer great obstacles to the detection of a calculus, and when a calculus becomes encysted an insurmountable source of difficulty exists. In other cases of difficulty, attention to a few practical rules will much assist us. In examining persons with enlargement of the prostate, who are suspected to labour under a stone, a sound of the shape and curve of the lithotrite is certainly better fitted than the sound in common use for reaching the *bas-fond* of the bladder, the probable situation of stone in these cases. Mr. Crosse (*Treatise on the Formation, Constituents, and Extraction of Urinary Calculus*, p. 55, 4to. Lond. 1835) mentions that Mr. Pearson occasionally used a catheter of this shape, and found it enter the bladder when an instrument of a different shape would not. No examination of the bladder, when the prostate is enlarged, should be considered complete, in which an instrument of this shape (provided the stone is not felt with the common sound) has not been employed. Again, the introduction of the finger into the rectum is an auxiliary, which, especially in these cases, and indeed in most other difficult cases of stone, should not be neglected. It is singular that M. Civiale, whose experience in calculous affections is so great, should speak so lightly of this mode of examination.† In the second case which I have related, the stone could not be felt with the sound, until the finger was introduced into the rectum, and the operation was almost on the point of being abandoned. Mr. Crosse says, "I should deem myself as little justified in omitting this method of exploration, as in operating without having sounded at all."

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* I purposely exclude such a contracted state of the urethra as prevents examination of the bladder with the sound.

† "En effet, veut-on explorer la partie prostatique de l'urètre et le col vesical? le doigt se trouve séparé de la partie malade

In children and grown up persons with irritable bladders, the contraction of the organ renders it difficult to detect the calculus. In this state it is desirable not to examine the bladder in an empty state; and if this organ be irritable, the irritation should be subdued by appropriate means, to enable the bladder to contain a fair quantity of urine. In the first case which I have detailed, I have little doubt in my own mind that the fear of the operation caused the escape of the urine, and that the stone was consequently embraced by the folds of the bladder, and could not be felt. When the operation was performed, the boy had no previous knowledge of what was to take place, for I was in a state of uncertainty myself, from what had occurred, whether I should be able to feel the calculus. In the

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par un plancher épais, dur et résistant, à travers lequel le tact le plus délicat ne saurait rien discerner. S'agit-il d'atteindre la pierre située dans le bas-fond de la vessie? pour peu que la prostate soit engorgée, et même alors qu'elle ne l'est pas, le doigt ne saurait arriver jusque là; sa pulpe appuie sur la face inférieure de la prostate, et rarement elle s'tend au bord posterieur, entre les vesicules séminales et les conduits spermatiques; les cas dans lesquels il serait le plus facile de palper cette région de la vessie sont précisement ceux où l'on n'a aucun intérêt d'introduire le doigt dans le rectum."—*Traité de l'Affection Calculeuse*, p. 476.

third case which I have given, the situation of the stone was the cause of the difficulty in detecting it. If a calculus be situated behind the pubes, or be adherent to the fundus of the bladder, or be impacted in the vesical extremity of the ureter (one portion being within the ureter, and the other projecting into the bladder, as occurred in a case of Dr. Prout's), great difficulty will be experienced in detecting the stone. In suspected cases of this kind, the patient should be examined in various positions, and the bladder should contain a moderate quantity of fluid. Again, the small size of a stone may render it difficult of detection ; and the best surgeons may then use the sound several times before they can be satisfied of its existence. In the forty-third volume of the "London Philosophical Transactions," Mr. Nourse relates the case of a patient in whom the calculi, nine in number, and contained in six separate cysts, were detected in the first sounding, but never afterwards. Ellerus relates a case in which a stone was contained between the coats of the bladder.

There are preparations showing a sort of hour-glass construction of the bladder, in which no sound could have passed into one of the compartments.

Müller mentions the case of a boy, in whom the following morbid condition of the urinary organs existed. The prostate gland was converted into an immense pouch, in which the catheter was arrested and did not pass into the true vesical cavity, in which a stone was lodged. The patient was sounded twice without any stone being discovered. The third time, however, it was detected, and the operation was actually performed ; a large quantity of pus escaped, but no calculus was found. The patient died, and on dissection it was perceived that the bladder had contracted tightly round a concretion the size of a small lemon. The prostate was partly destroyed by suppuration, and presented an enormous cavity, which had been mistaken for the bladder, and into which the instrument had wandered during sounding.

A variety of anomalous symptoms may combine and simulate those of stone. Among such curious cases is one related by Mr. Fenwick, in the "Lancet," Jan. 24, 1846, where an aneurism of the abdominal aorta gave rise to symptoms which misled the surgeons attending the patient. There was violent pain at the extremity of the penis and in the pubic region, during and after micturition; there was pain in the kidneys and epigastrium; the urine was red and deposited a thick sediment; the tongue was white, and the appetite bad. The symptoms appearing to indicate the presence of stone in the bladder, a sound was introduced, but no calculus could be detected. There was nothing which created a suspicion that the disease was aneurism. The patient, soon after he was admitted into the infirmary at Newcastle-upon-Tyne, died under symptoms of great exhaustion, preceded by sudden fainting. The abdomen was found filled with blood, which had proceeded from the rupture of an aneurism of the aorta, about the size of an orange; it had produced caries of the bodies of the vertebræ on which it rested, and was accompanied by hypertrophy of the left ventricle of the heart and thickening of the tricuspid valves. There was no calculus in the bladder, and no disease in any portion of the urinary organs.

From the preceding remarks, it is clear that, though calculi are contained in the bladder, it may be difficult, if not impossible, to ascertain their existence during life; that the bladder may be sacculated; and that an excavation may exist immediately behind the prostate, or on one side of it, in which the stone may easily escape detection. In persons far advanced in years, a secondary cavity, occupying the fundus of the bladder, bounded above by the prostate, behind by the orifices of the ureters, and the intervening portion of the parietes of the bladder, may contain the stone firmly fixed in it; this state being generally accompanied with ulceration of the coats of the bladder. In other cases the stone may be, as it were, pinched between two folds of the bladder; or be fixed in a cul-de-sac, formed either by a hernia of the mucous membrane in consequence of a rupture of the muscular fibres, as so often happens in what are called columnar bladders (vessies à colonnes), or by a real cyst round the stone. (*Velpeau's Médecine Opérative,* 2nd edit. 1839, tom. iv., p. 484.)

The calculus having been found, the next question to be considered is the method we are to select for its removal.

CHAPTER XVII.

LITHOTOMY.

There are three different parts at which the bladder may be opened for the purpose of extracting calculi :—

I. At the anterior and superior surface above the pubes, called the high operation.

II. At the inferior and posterior part by the rectum, called the recto-vesical operation.

III. At the neck, through the prostate gland, by the perineal section, called the lateral operation.

The High Operation.—In order to perform this operation, the bladder must rise above the superior edge of the pubes, which, when empty, it does not reach. Hence, it is necessary to distend the bladder with injections ; or to wait until sufficient urine has accumulated to produce the desired effect ; or to elevate the anterior and superior part of the viscus by means of a sound, the point of which must be made to glide from below upwards, against the posterior surface of the pubes. It is obvious, therefore, that the operation is impracticable in all cases where the bladder does not readily admit of distension. Should the presence of the stone have produced irritability of the organ, or thickening of the parietes, a sufficient quantity of fluid cannot be injected into its cavity.

This method of operating is now nearly abandoned in Great Britain, though it is still practised in France; and, judging from its results in the hands of M. Souberbielle, with a very fair amount of success in the worst description of cases, viz., those in which the stone is of large size. M. Souberbielle is indeed a great advocate for the high operation; and in a memoir presented to the Royal Academy of Medicine in 1835 and since published, gives the following particulars of fifty operations performed by this method:—

Ages.	Number of cases.	Cured.	Died.	Ratio of Mortality.
Under 10	9	39	11	1 in 4½ nearly.
11 to 40	3			
40 to 50	1			
51 to 60	5			
61 to 70	13			
71 to 80	17			
80 & upwards	2			

Up to the age of twenty-two no patient was lost. The mortality of eleven has therefore to be divided among about forty subjects, which brings it nearly to 1 in 3⅔. Many of M. Souberbielle's cases were unfavourable; in three the stone weighed four ounces, and in two it weighed five ounces; six of the patients, moreover, had already submitted to lithotomy; and, in twelve, attempts had been made to grind or crush the stone. Mr. Carpue, having witnessed many of M. Souberbielle's cases, endeavoured to reintroduce this operation; and Mr. Humphrey of Cambridge, has by means of it recently extracted a calculus with success. Professor Gibson, of Philadelphia, performed it in the case of an old gentleman who was affected with great enlargement of the prostate gland; but the patient died soon afterwards from peritonitis consequent upon urinary effusion. Dr. Carpenter of Lancaster, Pennsylvania, repeated the operation soon after with a more fortunate result. Dr. George Mc'Clellan of Philadelphia, performed the operation several times; but the results did not encourage others to follow his example. It seems to be an easy and a simple operation; but such is not the case, and the objections, which induced Cheselden, Douglas, and others to relinquish it, are based upon very good grounds. It is true there is no danger of hæmorrhage; that neither the rectum nor the ejaculatory ducts can be wounded; but then the bladder cannot always be fully distended, and there is great risk that the peritoneum may be injured. Such an accident is immediately followed by the protrusion of some folds of intestine, and probably by acute peritonitis; or the bladder being opened, and the peritoneum wounded, urine may escape into this cavity, and produce fatal results. The force sometimes necessary to distend the bladder to a sufficient extent for the high operation may be illustrated by two fatal cases of Cheselden's, in which the bladder was burst from injecting too much water.

When there is a great accumulation of fat in the supra-pubic region, the external incisions must be both long and deep; and the bladder, when opened, lying at a distance from the surface, cannot satisfactorily be explored; neither, under these circumstances, would it be a fit proceeding for the extraction of an encysted calculus.

The operation is most easily performed on young subjects, in whom the pelvis is small, and the bladder still to be enumerated among the abdominal viscera. But these are the very patients upon whom the lateral operation may be performed with the greatest prospect of success. A patient may be labouring under such extensive disease of the bladder and kidney as to almost render any operation improper; but it has never occurred to me to meet with a case in which a better chance of recovery would occur from opening the organ above the pubes. Even in the case of a very large stone, when fears may justly be entertained that there may be insufficient space for its extraction entire under the arch of the pubes and through the perineum, I do not consider the high operation advisable; for the bladder in almost every instance of the kind is thickened, contracted, and incapable of distension behind the pubes, and no instrument can be introduced through the urethra to assist in elevating its anterior wall to the line of incision.

This operation, however, being decided upon, the patient should be placed in the recumbent posture, with the shoulders slightly elevated, and the feet resting on a chair. The parts having been shaved, and the boundary of the distended bladder being clearly ascertained, the surgeon should make an incision from three to four inches in length along the mesial line, commencing about half an inch above the symphysis pubis. The aponeurosis of the obliquus externus abdominis having been exposed, a small opening is to be made into the supra-pubic space, which is filled with fatty cellular tissue, and bounded above by the reflexion of the peritoneum from the urachus to the posterior surface of the abdominal walls. A grooved director having been introduced, the linea alba is to be divided to the requisite extent. Hæmorrhage having been arrested, the bladder is to be sought for, which feels like a soft fluctuating tumour at the bottom of this deep wound. The organ may be secured by a hook, or tenaculum given to an assistant, to prevent it, when opened, collapsing beyond the reach of the operator. A small opening having been made into its lower and front part, the knife should be introduced, with its edge directed upwards. The instrument should be cautiously carried upwards for about two inches, its course being guided by the fore and middle fingers of the left hand introduced into the vesical cavity. It is safer for this last part of the proceeding to use a knife with a rounded or a probe-pointed extremity. The forceps must now be introduced, and the calculus extracted. A gum elastic catheter, or a silver tube should be left in the wound, for the purpose of preventing infiltration of urine into the cellular tissue of the pelvis and of the lower part of the abdomen.

In a case operated upon by Pye, fatal hæmorrhage ensued. "In the old method of performing this operation," says Carpue, "hæmorrhage must be common, as I have been sent for to examine three persons who died shortly after the operation, and in whom, on inspection, I found the cause of death to be hæmorrhage from the puncture of a branch of the circumflexus ilii, which anastomosed with the epigastric."

The high operation should, in my opinion, be reserved for those cases—extremely few in number—in which the pelvis is so deformed that the proper incisions cannot well be made in the perineal space. "I once saw," observes Mr. Bransby Cooper, "the high operation performed by Sir Everard Home, and a most difficult operation it was: after he had cut down through the parietes of the abdomen, he was obliged to make an opening in the perineum, and pass an instrument into the bladder from below to enable him to open the bladder above the pubes. After much difficulty, a calculus was removed, but the patient died, in consequence of this complicated operation, a few hours after its completion. A friend of mine," he adds, "some years since, was present at the performance of the high operation of lithotomy, by M. Civiale, of Paris. In making the first incision through the parietes of the abdomen, he wounded the peritoneum, which led to the protrusion of the small intestines. He returned these into the abdomen and continued the operation, and ultimately succeeded in extracting a stone. The patient was put to bed, and M. Civiale, on subsequent consideration, dreading the liability of extravasation of urine into the peritoneum, determined upon laying open the bladder from the perineum. He effected this, and so completely succeeded in preventing the result he feared that the patient ultimately recovered."

The Recto-vesical Operation, claimed by Sanson as his own, has been recommended on the ground of being free from the danger of hæmorrhage, and of affording a ready passage to the instruments necessary to seize and extract the stone. Sanson divides the sphincter ani and the lower part of the rectum by a vertical incision corresponding to the raphe of the perineum. Continuing the dissection, he exposes the bulb and membranous portion of the urethra, the prostate gland, and the lower wall of the bladder. The prostate gland may then be divided upon a staff introduced into the bladder through the urethra, or the knife may be passed behind the prostate, through the wall of the bladder into the groove of the staff, and the base of the bladder divided.

The objections to this operation are very grave. When the cavities of the rectum and bladder have been thrown into one, it is by no means certain that the communication will close. I have myself witnessed cases in which a recto-vesical fistula has remained for years, the result of an incised wound. The division of the prostate exposes the vasa deferentia to danger, and the wound of the neck of the bladder may be complicated with a wound of the vesiculæ seminales, producing atrophy of the testicles. The recovery from such an operation must necessarily be tedious, and the whole proceeding is even more objectionable than the operation above the pubes.

But it has already been discarded ; and cannot be recommended even in those cases where the calculus is impacted in the walls of the bladder. Although the danger of hæmorrhage is stated to be inconsiderable, arteries of some size may be wounded by so deep an incision.

The Lateral Operation.—The lateral operation has superseded every other method of extracting calculi from the bladder. I have performed it at all ages, from eighteen months to eighty years. Mr. Cline operated upon a man of eighty-two; Sir Astley Cooper upon one of eighty-six; Dr. Physick removed at one operation from Chief Justice Marshall, of the United States, a man of very advanced age, upwards of a thousand small calculi, varying from the volume of a partridge shot to that of a bean. Mr. Attenburrow operated successfully upon a man of eighty-five. Mr. Keate performed the lateral operation upon an infant of twelve months; Mr. South upon one of twenty months. Civiale refers to a child that was cut at ten weeks.

In very young subjects the bladder is somewhat of an abdominal viscus; but the perineum is devoid of fat, the parts are very thin, and the bladder can be readily reached by the finger of an adult. Cases of lithotomy usually do well in young children, and collapse, so common in middle age, does not occur.

Contemplating lithotomy, the surgeon should be extremely particular in preparing his patient for the operation—in fact, the most successful lithotomists are those who are most attentive to this point. If the patient's health be much impaired, and the bowels are relaxed, which is not unfrequently the case in children,—or if the urine be alkaline,—he must, before the operation, lessen by an anodyne the irritability of the bladder and bowels, and improve the patient's health, as far as possible, by medicine and attention to diet. I generally give, on the night preceding the operation, a few grains of hydrarg. c. cretâ, with the pulv. rhei, and, some castor oil early on the following morning. Two clysters should be given before the operation—one, two or three hours after the castor oil, composed of gruel, olive oil, and salt; and the other about an hour before the operation, consisting of common gruel with twenty or thirty drops of laudanum in it. If the last injection has not come away when the surgeon arrives to perform the operation, he should urge the patient, if an adult, to go to stool; if a child, it will generally happen that the injection, if it has not passed off, will do so when the staff is introduced. On no account should the surgeon undertake the operation till the injection has come away.

The existence of organic disease in any important structure is a most unfavourable circumstance as regards the ultimate success of the case. Tubercles in the lungs, a granular condition of the kidneys, and other similar diseases, seem to exert upon the patient a depressing influence from which he suffers after the operation when the wound is healing in the usual way. These morbid changes of structure should be ascertained; not that they admit of much relief by treatment; but that they may put us on our guard as to giving too encouraging a prognosis. The mortality in a given number of such cases is sure to be considerable.

The perineum having been shaved, and everything in readiness for the surgeon, the patient should be placed evenly on his back, and supported by pillows upon a table of convenient height—about two feet and a half from the ground.

The stone is first to be clearly felt with the sound, or, as some prefer it, with the staff. I prefer the former instrument, as being more manageable and less likely to stretch or tear the urethra. If I have any doubts as to the condition of the prostate, I examine the part by the rectum ; but this proceeding, as well as the examination of the pubic arch, should be made the day before the operation.

The stone having been felt, the sound withdrawn, and the staff introduced, the patient must be made to raise and separate the thighs, and to grasp each foot with the hand of the same side. The hands and feet are then to be securely bound together by a broad garter wound round the ankle and wrist, and including the instep and hand. These bandages should be carefully applied by two experienced assistants, standing one by the right, the other by the left knee. If the bandages slip during the operation, the patient may twist and no longer lie evenly on his back—circumstances of serious moment especially to a young operator. Some surgeons recommend that the patient should be tied before the introduction of the staff, that there may be no escape of urine. To this I object, because the introduction of any instrument along the urethra into the bladder is by no means so easy when the thighs are flexed upon the abdomen as when they are in their usual position.

Surgeons have successfully operated with staffs of every shape, from the greatest curve to the perfectly straight instrument of the late Mr. Aston Key, and hence we may conclude that the importance usually attached to this part of the proceeding is of little consequence to one who thoroughly understands the anatomy of the perineum. Still the staff should possess a curve of sufficient length to enable the point to enter fairly into the bladder; and the groove should be deep, situated either in front or a little to the side, and cease about a quarter of an inch from the extremity of the instrument. I give the staff to the care of an assistant, directing that the handle, which should be broad and rough, so as to be easily and firmly grasped, be inclined a little towards the ground. By this inclination of the handle, the groove of the staff is certainly made less prominent in the perineum; but there is this advantage attending it, that when the surgeon has cut into the groove, there is no occasion to alter the position of the staff, and the fore-finger of the left hand is quite at his disposal for protecting the rectum, and guiding the knife. I find that I can perform the operation much more rapidly in this way, than by taking the staff into my own hand. If the groove be directly in front of the instrument, it must be slightly turned towards the left side.

Sitting upon a low chair, I commence the first incision rather low—about two fingers' breadth above the anus—by which precaution the bulb of the urethra will be avoided. In fact, the external incision, if commenced higher, can be of no use to the operator; and I find that this, the upper part of the wound, is often the slowest to heal. Mr. Skey says (*Operative Surgery*,

p. 543) that "in order to meet the greatest of difficulties in the operation of lithotomy, that of cutting into the groove of the staff, it is most desirable that the staff should be brought close to the surface of the perineum, and distinctly felt by the finger pressing it." I consider it, however, important that the instrument, corresponding as closely as possible to the natural curve of the urethra, should be introduced so as not to alter one single natural relation of the parts ; and that, when once in the bladder, it should be held there immoveably until withdrawn. I have never found difficulty in finding the staff as it lies close under the pubic arch, nor do I use the instrument in any way as a guide and support to the first incision. The use of the staff may be defined to be that of conducting the knife along its groove from the membranous portion of the urethra, through the prostate, and into the bladder. It should be employed for no other purpose.

The surgeon should begin the incision of the integuments on the left of the raphe, about an inch in front of the anus, and terminate it between this opening and the tuber ischii. The fatty cellular layer comprised between the left erector penis and accelerator urinæ, as well as the fibres of the transversus perinei muscle, are then divided, and the membranous portion of the urethra is opened, so that the groove of the staff can be distinctly felt.

Having made these incisions with the common scalpel, I then take a long straight knife, with a knob at its point, and convey it along the groove of the staff until it reaches the bladder, dividing in its course some of the anterior fibres of the levator ani, the lateral and lower part of the prostate, the capsule of which must be left entire. I then withdraw the knife in the direction of the external wound, and introduce the left fore-finger into the bladder. Being satisfied that the cavity of the organ is sufficiently laid open, I direct the staff to be withdrawn and introduce a pair of broad-bladed forceps along the finger. The stone is then seized and extracted. It is scarcely possible to say too much as to the caution necessary in the extraction of a large stone. We are to withdraw it gradually from the bladder, endeavouring to dilate the parts through which it is to pass, instead of tearing them ; and it is astonishing to what an extent this gradual dilatation may be accomplished in the hands of a prudent surgeon.

A source of difficulty (*Mr. Lee on Lithotomy and Lithotrity*, p. 19) not unfrequently arises to prevent the seizure of the stone and its extraction, from the forcible contraction of the bladder upon it, which the introduction of the forceps and attempts to find the stone tend to provoke. This impediment sometimes considerably prolongs the operation, and even occasionally prevents its completion ; the danger being increased in proportion to the length of time occupied in the attempts, the patient becoming exhausted, and the parietes of the bladder bruised, and perhaps pinched or lacerated by the forceps. In these cases, by waiting a little while, the contractions of the bladder will often cease, and permit the removal of the stone with facility ; whereas, on the other hand, the repeated introduction of instruments, and the fruitless trials to seize the stone, when the surgeon is anxious to perform the operation quickly, without due regard to the difficulties he may encounter, will, in many cases, excite still more the contractility of the bladder, and thus prevent the desired object. Mr. Crosse mentions, in his work, a case where three-quarters of an hour were uselessly employed in attempts with the forceps to find a stone, of the size of a pigeon's egg, which came out of itself some time after they had been discontinued.

Mr. Fergusson is in the habit of opening the blades of the forceps at the moment of withdrawal of the finger, and of catching the stone with remarkable dexterity as it is driven by the gush of urine within their grasp. I view this proceeding as one of considerable importance ; for the greatest occasional difficulty in the operation, as far as my experience is concerned, has arisen in laying hold of the stone with the forceps. As to cutting into the bladder, this is a very simple proceeding to any one acquainted with the anatomy of the parts and provided with proper instruments. The difficulty is in seizing and withdrawing the stone ; and here the surgeon should pull downwards, so that he may avoid the narrow part of the arch of the pubis, and he should do so slowly, in order rather to dilate than to tear the different structures intervening between the bladder and integuments.

If the stone breaks under the forceps, as will probably happen when there is a fusible calculus, we must endeavour to remove as much of the calculous matter as is practicable with the scoop at the time of the operation, and then well wash out the bladder. We must not, however, be content with washing out the bladder at the time of the operation, but should repeat this proceeding before the wound in the perineum closes. In a patient of my own, fifty-six years of age, in whom the stone was like a mass of mortar, more than an hour was occupied in removing with the scoop the calculous matter ; but a great deal was still left behind. I feared the consequences of protracting the operation, and the patient was removed to bed. At the end of a fortnight, I introduced a large catheter through the urethra, and well washed out the bladder, a great deal of lime escaping through the wound in the perineum. I repeated this every other day for a fortnight ; in fact, until no more calculous matter escaped. The patient is now quite well, and has had no return of stone. Dr. Snow administered the chloroform at the operation, and at each washing out of the bladder.

In order to avoid with greater certainty the spongy portion of the urethra, some surgeons advise the operator to push the internal lip of the wound inwards, with the fore-finger of the left hand, and to cut on the nail of that finger. A division of the trunk of the internal pudic artery would be a much more serious occurrence than a wound of the bulb ; but the vessel is very rarely cut, for, to reach it, the incision must be extended downwards and outwards, even as far as the bony parts of the pelvis, against which the artery rests. On the other hand, if, to avoid this accident, the operator does not carry the incision with sufficient obliquity outwards, he runs the risk of wounding the rectum.

It must be remembered, however, that varieties do occur in the course of the internal pudic artery ; and that occasionally a large trunk runs by the side of the neck of the bladder to the prostate to become the dorsal artery of the penis. A wound of this vessel in the adult would be attended by serious consequences, and even in children considerable and dangerous hæmorrhage might follow its division. I hope that every one who ventures to undertake this serious operation will bear in mind, not only the natural relation of the parts, but likewise the varieties in the distribution of arteries that possibly may cross his path. The direction which should be given to the incision of the prostate, and its extent, are also points of the greatest importance to the success of the operation. Cheselden is supposed to have divided in his operation as little as possible of the prostate gland.

The first account (*Willis on Treatment of Stone*, p. 182) we have of Cheselden's operation, is in his Appendix to the fourth edition of the "Anatomy of the Human Body," which appeared in the year 1730. In this Appendix, after describing the first stage of the operation, he goes on to say: "I then feel for the staff, and cut upon it the length of the prostate gland straight on to the bladder, holding down the gut all the while," &c. &c. In the Appendix to the fifth edition of "Anatomy," published ten years later, viz., in 1740, the description is the same, till we pass the words "I then feel for the staff," when he proceeds—"holding down the gut all the while with one or two fingers of my left hand, I cut upon it in that part of the urethra which lies beyond the corpora cavernosa urethræ, and in the prostate gland, cutting from below upwards to avoid wounding the gut." Dr. Yelloly, in a learned and very able paper published in the fifteenth volume of the "Medico-Chirurgical Transactions," (Lond., 1829,) speaks of these two operations as identical. If the words in which they are described be taken in their most simple signification, however, it seems to me that the two operations are totally different. In the one, the first—the prostate is cut in its whole length, and the knife in the groove of the staff is passed from before backwards into the bladder; in the other, the second and later operation—the knife is entered through the distal edge of the prostate only, and the membranous part of the urethra is slit open from behind forwards. The first method is the lateral method of the English surgeons of the present day; the second method has scarcely, if it has ever, been intentionally performed since Cheselden himself ceased to operate: nevertheless, that it was the one which he approved, there can be no doubt; for it is that with which his most brilliant successes were achieved, and it is that which is found in the next and only other edition of the "Anatomy" which appeared during his lifetime, namely the sixth, which issued in 1750.

Mr. Martineau, one of the most successful lithotomists of modern times, divided only a part of the prostate gland; Mr. Crosse (*On the Formation, Constituents, and Extraction of the Urinary Calculus*), who witnessed for many years Mr. Martineau's public practice, says (p. 156), "that he (Mr. M.) seldom if ever divided the prostate gland through its entire depth, is the opinion I have formed from observation of many operations by him, and which is supported by the only dissection I had the opportunity of making; still, enough was cut to allow the blunt gorget to enter the bladder, and then the operator invariably adopted a proceeding which forms no unimportant part of the operation: the staff being withdrawn, he was accustomed to introduce his left fore-finger (which was particularly long and large) upon the concavity of the gorget, into the bladder, forcibly dilating the opening, and using the finger as a powerful but safe instrument for rendering the neck of the bladder ample to admit the forceps. The force and determination with which the finger was thus used, dilating, if not lacerating, the remaining undivided portion of the prostate gland and the neck of the bladder, I always regarded as a peculiar and intrinsic part of Mr. Martineau's method of operating. The opening into the bladder being thus effected, partly by cutting and partly by dilating, the forceps usually entered readily, and in the use of these, rapidly carrying them to different parts of the bladder if required, or more frequently seizing at once the stone (previously felt and its situation ascertained by the finger), Mr. Martineau possessed a degree of freedom and dexterity unparalleled within my observation, and surpassed most surely by very few among those who have become conspicuous in this branch of operative surgery."

Whatever may be the difference of opinion respecting the mode of making a passage into the bladder, the dangers of completely dividing the prostate are apparent. The urine, escaping into the loose cellular tissue of the pelvis, produces inflammation and gangrene, and the patient almost certainly dies, labouring under symptoms of a typhoid character.

A small calculus, which not uncommonly escapes from between the blades of the forceps, may often be easily removed by the scoop, a spoon-shaped instrument, about a foot in length, with a slightly curved extremity. Still I must confess that I have rarely occasion to use this instrument, unless indeed it unfortunately happens that the stone breaks into fragments in the bladder.

The bladder should always be most carefully searched for any other urinary concretion. I am not in the habit in all cases of injecting the bladder, and washing it out with warm water. If I am sure that the calculus is single, my directions are to remove the patient to his bed as soon as possible. Thus very few minutes suffice for the whole proceeding.

Difficult as may be the extraction of an impacted calculus, still more so is that of one so large as to require for its passage incisions longer than those usually made. A stone of from four to eight ounces weight cannot be safely removed without the greatest coolness and skill. If the size of the stone be such that no dilatation of the wound as first made will admit of its extraction, it may be crushed ; or the right lobe of the prostate may be divided, or a combination of both these proceedings may be adopted. As regards the shape of the crushing forceps, I do not attach so much importance to it as is done by others. If the blades be sufficiently strong, a well made forceps will break most urinary concretions ; but a variety of crushing forceps, of different lengths, some straight, others curved, with blades flat and broad, or narrow, spoon-shaped, rough, or cutting, should always be at hand. Mr. H. Earle paid particular attention to the subject of extracting large calculi, and has communicated to the profession some interesting matter in the eleventh volume of the "Transactions of the Royal Medical and Chirurgical Society."

Cheselden withdrew a calculus of twelve ounces, and succeeded in curing his patient; Mr. Harner, of Norwich, removed by lateral section a stone of the weight of fifteen ounces, its diameter being four inches and three quarters in one direction, and three and a half in the other.

In 1818, Mr. Charles Mayo of Winchester, operated upon a man aged twenty-eight, and extracted a stone of fourteen ounces and two drachms avoirdupois. It measured eight inches and a half in its smaller circumference, by rather more than ten in the largest, and broke into several large pieces in the attempt to extract it.

Ambrose Paré relates the case of a confectioner, who was cut in 1570, by John Collot, where the stone weighed nine ounces, and was three inches and a half in diameter. In an instance described by Folet, a calculus weighing ten ounces, and measuring nearly four inches in diameter, was happily extracted, and the patient had recovered from the immediate effects of his wound, when an abscess formed in the kidney from the presence of a concretion, and terminated fatally on the tenth day from the operation.

The influence which the size of the calculus has upon the mortality after the operation of lithotomy, is a point which has of late years attracted considerable attention. The cases related above are exceptional. It is well known that the extraction of a very large stone is generally fatal to the patient; but we have scarcely any data from which we can deduce the relative influence exerted by stones of different sizes. The late Mr. Crosse was the first writer who viewed this subject as one of interest and importance, and who had materials at his disposal, from which other than either purely individual or extremely general inferences could be drawn. From the valuable Norwich data, Mr. Crosse (*Op. cit.* p. 162) has presented us with the following table of 704 calculi, arranged according to the weight, with the result of the operations performed for their removal.

Weight.	Number of Cases.	Cured.	Died.	Ratio of Mortality.
1 oz. and under.	529	482	47	1 in 11⅓ nearly.
1 to 2 oz.	119	101	18	1 in 6⅔ —
2 to 3 oz.	35	19	16	1 in 2⅕ —
3 to 4 oz.	11	4	7	1 in 1$\frac{4}{7}$
4 to 5 oz.	5	2	3	1 in 1⅖
5 to 6 oz. 6 to 7 oz.	4	2	2	1 in 2

The information which this table conveys is extremely important. With a stone one ounce in weight and under, it is obvious that the chances of a favourable issue are nearly twice as great as with a stone between one and two ounces in weight, and nearly six times as great as when the stone weighs between two and three ounces. The mortality with stones of every weight over an ounce is nearly 1 in 3¾ths; and with those over two ounces it is something more than 1 in 2. Of the 55 instances in which the stone weighed two ounces and upwards, 27 recovered and 28 died. The chance which a patient has for recovery after lithotomy can therefore be calculated beforehand, and independent of every other consideration, from the ascertained dimensions or weight of the stone. Doubtless, some considerable portion of the greater comparative success that attends lithotomy in early life is due to the generally smaller size of the stones that are then extracted.

A certain moderate size of stone, however, would seem rather to be advantageous than otherwise; the most favourable results are not associated with the smallest stones, as is apparent from the particulars conveyed by this table, from Mr. Crosse's work, of the 529 calculi of the preceding table that weighed 1 oz. and under:—

Weight.	Number of Cases.	Cured.	Died.	Ratio of Mortality.
1 dr. and under	134	122	12	1 in $11\frac{1}{6}$
1 to 2 drs.	111	101	10	1 in $11\frac{1}{10}$
2 to 3 drs.	95	90	5	1 in 19
3 to 4 drs.	68	60	8	1 in 8
4 to 5 drs.	29	28	1	1 in 29
5 to 6 drs.	38	35	3	1 in $12\frac{2}{3}$
6 to 7 drs.	24	21	3	1 in 8
7 to 8 drs.	30	25	5	1 in 6
Total	529	482	47	1 in $11\frac{1}{3}$ nearly.

With stones under two drachms in weight the mortality is therefore greater than with those that are between two and three drachms, and particularly with those between four and five drachms: the chances of recovery with this last weight of stone are actually about two and a half times greater than with a stone that weighs less than a drachm. A certain moderate size in the calculus is therefore an advantage, I believe, because stretching is brought to the aid of cutting. About and above the ounce weight, tearing is added to stretching, and immediately the mortality rises.

Measurements of calculi would be far more important elements in forming estimates of this kind than weights ; it is the size of the stone that determines the extent of outlet necessary to give it passage, and this extent of outlet it is that influences the mortality : large stones often weigh less than might be inferred from their size ; small ones, again, are frequently remarkably solid and heavy.

Mr. Charles Preston (*Philos. Trans.*, Lond., xix., p. 310) states that he saw, at Paris, a stone which weighed fifty-one ounces, which was taken from a religious brother in 1690, who died before the operation was concluded.

Deguise (*Recueil Periodique*, t. vii., p. 423, et t. xiv., p. 424) removed one of thirty-one ounces from a patient aged sixty-five by the high operation, having previously opened the bladder through the perineum. Death ensued on the sixth day. Sir Astley Cooper cut a man, æt. forty-three, and found a stone which weighed sixteen ounces. The long diameter was four and a half inches, in the short axis three and a quarter. It could not be broken, such was its firmness, and the wound in the perineum had to be extended as far backwards as the sacro-sciatic ligament. The patient survived the operation only four hours. Dr. Mott, of New York, removed a triple phosphate calculus, weighing seventeen ounces and two drachms, by the ordinary operation, from an elderly gentleman, who died on the fifth day.

Mr. Fletcher (*Medico-Chirurgical Notes and Illustrations*) relates the following case, showing the danger of violent attempts at the extraction of a calculus. A healthy middle-aged man, of unusual moral energy and excellent spirits, underwent the lateral section with firmness and alacrity; although the bladder was opened without difficulty by a free incision, the stone would not pass. After exerting himself to no purpose, the operator rested, and then recommenced his labours with redoubled vigour, placing his right foot against a chair, which was supported by a pupil. After the lapse of nearly two hours, his efforts were at length successful, but the man was so much exhausted that he expired in a few minutes after being carried to bed. The calculus exceeded five ounces in weight; the body was not examined.

The Transverse or Bilateral Operation may be viewed as a modification of the lateral operation, and was highly vaunted by Dupuytren. It was first introduced by Le Dran, although it is commonly ascribed to Celsus. The surgeon, having placed the patient in the same position as in the lateral operation, makes a semi-lunar incision, the centre of which is situated in front of the rectum, behind the bulb, and the extremities of which are turned outwards and backwards towards the tuberosities of the ischia. The skin, fat, and a few fibres of the sphincter ani muscle are divided, the membranous portion of the urethra is opened, and the incision extended from right to left in the substance of the prostate, so as to form a triangular flap, which contains the vasa deferentia and verumontanum, and the inferior half of the prostatic portion of the urethra. By this means an opening much larger than that procured by the lateral operation is obtained, and the injury of the ducts is more certainly avoided ; while there is no hæmorrhage of importance to be dreaded.

The bladder should be opened by the lithotôme in the following manner. After the superficial incisions, the staff having been found, the membranous portion of the urethra is to be opened to the extent of a few lines, and the lithotôme is then to be inserted into the groove of the staff. The handle of the instrument is then to be depressed nearly to a level with the abdomen, and the lithotôme pushed carefully onwards into the bladder. When fairly in the bladder the lithotôme is disengaged from the staff, and turned round with its concavity towards the rectum, and while in this position it is withdrawn, the blades being expanded by pressing on their springs. The forceps being then introduced, the calculus is easily extracted. The general preference in the present day however, is given, over the lithotôme, to the knife.

Death may ensue from many causes after the operation for stone:—

I. The patient may pass into a state of collapse, and die without any obvious morbid change to account for the event.

II. He may die from peritonitis.

III. He may die from hæmorrhage, either proceeding from a single large trunk or from a number of small vessels.

IV. Sloughing of the pelvic cellular membrane or phlebitis may supervene.

V. There may be previous disease of the kidneys. Inflammation of the mucous membrane of the bladder, ureters, and kidneys, is no uncommon complication.

The state of collapse or sinking is a curious phenomenon: less common, however, certainly since the introduction of anæsthetics, by which the patient is rendered insensible. The symptoms of this state are extreme deadly pallor, moist cold skin; pulse hardly perceptible; slow, irregular, and disturbed breathing; uprolled eyeball; thirst, restlessness, and incoherence. Incessant attention is demanded in this state. The patient should be laid in the horizontal posture; he should be enveloped in a heated blanket; and bottles containing hot water applied to the extremities. The patient should be kept extremely quiet, and be induced to swallow from time to time small quantities of some stimulus, such as hot brandy and water, ammonia, &c. This state may last, on and off, some hours, and during the whole period the watching must be unremitting.

Peritonitis does not usually follow the lateral operation; yet I have seen a few cases, characterised by the usual symptoms, viz. rigors, flushings, pains of undefined nature in the limbs; pain and tenderness in the umbilical region. The attack usually proves fatal on the third or fourth day. There is not always much room for treatment, the patient being considerably reduced by the operation. The application of leeches, and the administration of calomel and opium so as to affect the gums, are the usual remedies; but opiates here are of great avail when given in full doses, and continued so to produce a decided and prolonged effect.

Mr. Crosse, whose experience was very large, says, (*Op. cit.* p. 82,) " that as a separate malady, unaccompanied by urinary infiltration and diffuse reticular inflammation, peritonitis is, according to my experience, not frequent; it is known by the usual signs, and commences in the vicinity of the bladder, where the pain is first felt spreading thence over the peritoneal surfaces; the most active antiphlogistic treatment, by bleeding, low diet, fomentation, and counter-irritation, are required, and, if promptly and early practised, will arrest the disease. In children, who are rarely sufferers from diffuse reticular inflammation and urinary infiltration, peritonitis occurs, and yields to active treatment, particularly leeching freely the abdomen; but in the aged, urinary infiltration and reticular inflammation and suppuration are frequent in comparison with unmixed peritonitis: the surgeon seldom has to treat the latter, and when the combined diseased action is present, I must repeat that general bleeding and purging sink the powers without arresting the malady, and should be very guardedly undertaken by the surgeon."

Phlebitis may perhaps be properly mentioned here as occurring in those in middle life and the old. The French authors believe it to be extremely common, but certainly dissections in this country, after fatal cases, do not quite confirm the accuracy of this statement. I observe that the American surgeons entertain the same opinion as the English. Death in that country seems to have arisen from other causes than inflammation of veins and secondary purulent deposits.

In my experience dangerous hæmorrhage is not a common occurrence after the lateral operation of lithotomy. In young subjects the arteries are for the most part small. In old men the veins about the prostate may pour forth a considerable quantity of blood, but the liberation of the patient from his constrained position, and the application of cold usually suffice to arrest the bleeding. The artery of the bulb should not be wounded. There is no mode of guarding against the irregular distribution of the internal pudic artery, of which a fatal instance has been related by the late Mr. Shaw.

If hæmorrhage occurs, we must endeavour to compress the bleeding vessel with the finger. It is always a most untoward circumstance, though it is rare that patients die immediately from loss of blood. The arteries that necesarily lie in the way of the knife are not large enough to afford a hæmorrhage sufficiently rapid to induce fatal syncope; but the draining sometimes continues for hours, either backward into the bladder, or slowly by the external wound and gradually exhausts the powers of the patient. In general it comes on as soon as the patient has recovered from the shock of the operation, and the circulation is re-established. Secondary hæmorrhage occasionally occurs after ten or twelve days; but not after several weeks as mentioned by the older surgeons. In their operations, however, much violence was used, and it is more than probable that the coats of the arteries were often so much bruised, that they mortified and separated as a slough. Under these circumstances the accident now under consideration would occur at a much later period than in the present day, when danger of such roughness to living tissues is better and more scientifically understood.

In some cases of hæmorrhage, especially in old persons, a dose of opium acts beneficially; in addition, ice should be applied to the wound and the patient kept as quiet as possible.

Infiltration of urine, generally the result of a too free division of the prostate gland, produces inflammation, suppuration, and sloughing of the cellular tissue of the pelvis. When it occurs, there is heat and pain at the neck of the bladder, with pain behind the pubes; the face expresses anxiety; the pulse is small and weak; the tongue brown, furred, and dry; the wound glazed, the discharge fœtid. Prostration rapidly comes on, and the patient dies in a few days after the operation. The treatment is obvious, though too often of little avail; a free outlet should be made for the extravasated and infiltrated urine by external incisions; the patient's strength should be supported by beer, wine, brandy, beef-tea, and whatever nutriment he can take. A gum elastic catheter should be retained in the bladder, that the urine may pass off as soon as it enters this organ. Leeches are rarely proper; the patient's strength being too much reduced, but hot fomentations may be applied to the hypogastric region.

It is highly important that urine should escape freely from the wound soon after the operation. Retention may be caused by tumefaction of the wound, by spasm of the urethra, or by the closure of the wound by a mass of coagulated blood. Fomentations, or the careful introduction of a catheter will relieve the patient from the difficulty, which gives rise to very distressing symptoms, namely, sharp burning pains in the pelvis, pain along the penis, and great constitutional disturbance.

The rectum is sometimes wounded, but generally the opening closes with the cicatrisation of the wound in the perineum. In children such accidents are rarely productive of evil, but in adults recto-vesical fistula may be permanent.

Impotence is stated to be common after lithotomy, from division of the ejaculatory ducts. I believe this danger to be more imaginary than real. At all events I have operated upon many young children, who are now grown up in the full and perfect possession of the sexual power; some of them are married, and the fathers of families.

If no unfavourable symptoms ensue, the after treatment consists in merely keeping the patient quiet; though, with children, it is extremely difficult to carry this into execution. The knees, by some surgeons, are tied together, by others they are not; but they should always be kept raised, and the scrotum supported. No application is required to the wound; but the urine should be received on sponges, and the parts kept clean and dry. Some urine soon begins to flow through the natural passage. In a man above sixty, on whom I operated some time ago, a considerable quantity of water came through the urethra on the morning following the operation. The time, however, varies at which the water entirely ceases to pass through the wound; and, in some rare cases, urinary fistulæ remain.

In estimating the risks from lithotomy (says Dr. Willis), age is an essential element in the reckoning. The operation, previously to puberty, is a very different affair from what it is after this period. Very little information is, in fact, to be gained from statements of the results of the operation for all ages and sexes. It would seem generally to be of little moment who was the surgeon and what the operation; if the majority of subjects be youthful, the success will be considerable, the mortality may be no more than 1 in 20 or 25; if, on the contrary, the majority of the patients be adult and aged, the mortality will certainly be from 1 in 5 to 1 in 2, according to the period of life.

In females stone is not of frequent occurrence. Owing to their more regular habits, urinary calculi are seldom formed, and when they do exist, in consequence of the shortness and dilatability of the urethra, they are easily passed. Cases of calculi, however, occasionally occur, which require surgical interference for their removal. The most simple mode is to dilate the urethra with Weiss' dilator, so as to allow the introduction of a forceps into the bladder, and the extraction of the stone. The dilatation of the urethra will be materially facilitated by a small incision being made in the external meatus in the direction upwards towards the pubes; by a slight division of this kind, the urethra will easily admit of dilatation to a considerable extent. If the calculus be so large as not to admit of being extracted through the urethra, then it should be broken by means of the screw lithotrite, and the comminuted fragments afterwards removed by the scoop. Incontinence of urine is the chief inconvenience which follows the dilatation of the urethra, therefore the dilatation should not be carried further than is absolutely necessary for the removal of the stone.

Few cases are likely to occur in which a stone may not be removed from the female bladder by the above methods. If the stone cannot be extracted by these means then recourse must be had to the knife, and the operation may be performed in the following manner. A straight staff, or director, is to be introduced through the meatus urinarius, with the groove turned obliquely downwards and outwards, in a direction parallel to the ramus of the left os pubis ; a blunt-pointed bistoury is to be conducted along the groove into the bladder, and the whole extent of the passage to be divided. If this incision be not sufficiently large for the extraction of the stone, then the neck of the bladder must be divided ; the shorter the incision required in this part, the better for the patient's subsequent comfort.

CHAPTER XVIII.

LITHOTRITY.

Various efforts have been made from time to time to supersede the serious, and, before the introduction of æther and chloroform, the very painful operation of lithotomy. All these efforts, however, failed in their object; and the removal of stone by cutting into the bladder was the only effectual mode of getting rid of this complaint, until the discovery of the operation which I am about to consider, viz. that of crushing the stone in the bladder.

Some sort of attempt to crush the stone seems to have been made by Gruithuisen; but the first who brought the operation into general use is Civiale, and he was followed by Leroy D'Etiolles, Heurteloup, Amussat, Costello, and others. Jacobson, Charriére, and Weiss, have devoted no small amount of talent to the simplification of the instruments employed; and in order to perfect the operation, it chiefly remains now that the instruments should be so constructed as to grind the stone to a fine powder, by which the dangers of lithotrity would be materially lessened.

As the operation occupies some time, it is important to place the patient in a position which is not distressing to him, and not embarrassing to the surgeon in his manipulations. The patient used to be placed on what is termed a rectangular bed, which is not unlike the common operation-table. It is, however, rather shorter ; and the two legs which support the head and upper part of the body being attached with hinges, admit of being folded under, so as to depress, to any degree, the head and shoulders of the patient, and consequently the fundus of the bladder. The shoulders of the patient are supported by a wedge-shaped box, which, in a great measure, alleviates the painful dependence of the head. The receding of the patient is prevented by a leather strap passed round the shoulders, and buckled to the sides of the bed, while the feet are secured in slippers properly attached to it. The object of the inventor of this machine, Baron Heurteloup, was to raise the pelvis to such a degree, that stones situated behind the neck of the bladder, might, in the horizontal position of the patient, be thrown backwards, and seized with greater facility. Another object proposed by this invention, is to supply a fixed point for the instrument with which the stone is to be comminuted—a result fully obtained by a curved bar of iron attached by a screw to the foot of the bed. Most English surgeons, however, dispense with this bed, and place the patient on his back on a sofa or couch, with the pelvis supported by a thick cushion, so that it may be higher than the shoulders.

Civiale employed at first a silver canula, containing a steel tube furnished with three branches or claws, which could be protruded, separated, and closed, so as to grasp the stone, which was then scooped by a drill contained in the centre of the canula. When the stone was sufficiently excavated it was broken by an instrument called the *brise-coque,* or shell breaker. This, the early apparatus of Civiale and D'Etiolles, though stated to be capable of demolishing the hardest calculus, proved to be a failure. The necessity of frequently repeating the operation; the stretching of the urethra by so large an instrument; the danger of some accident occurring to the bladder; and the irritation to the bladder produced by the mass of sharp fragments when the shell was fairly broken by the brise-coque, are the chief reasons why this instrument after a time was abandoned.

The instrument commonly used in this country for performing the operation of lithotrity, is composed of two pieces of steel, one sliding longitudinally within a groove of the other. The extremity which enters the bladder is curved, but not in the manner of a common catheter; the curve being more abrupt, and the curved part considerably shorter. When the forceps are to be opened, the sliding piece is drawn towards the handle of the instrument, and thus the blades, when separated, are still kept parallel to each other. They are closed by an opposite movement, effected by turning a screw forwards. For the construction and perfection of these instruments, we are indebted to the perseverance and skill of Mr. Weiss of the Strand.

The original idea of curved instruments to act upon urinary calculi is no doubt due to Mr. Elderton, whose instrument is described in the "Edinburgh Medical Journal," for 1819. This was intended for the purpose of seizing the stone and filing it away, by a piece of steel passed along the stem of the instrument. Mr. Weiss' forceps for the extraction of calculi through the urethra, though not to be ranked among the lithotritic instruments, was of somewhat similar form, and was used for the first time on a patient by Sir A. Cooper, in 1820. Four years later, a curved instrument, not very unlike the lithotrite of the present day, was constructed by Mr. Weiss. An important improvement was afterwards effected at the suggestion of Mr. Oldham, by which a serious inconvenience formerly attending the use of the lithotrite is obviated. This consists of an opening being made in the curved portion of the convex branch, which, without weakening the instrument, allows of the detritus being pressed through, as the stone is crushed, instead of becoming collected between and clogging the branches,—thus impeding their closure and the consequent withdrawal of the instrument, an accident which not unfrequently occurred before this alteration was made. The curved lithotrite now in use is infinitely preferable to any other instrument which has heretofore been invented.

The method of Heurteloup, namely, that of seizing the stone by an instrument, and breaking it to pieces by a hammer, proved objectionable, inasmuch as the force of the blow could not be regulated. Injury may also be done to the instrument, and the blow frequently causes the stone to drop from between the blades. At the present time the screw is almost invariably used, and it possesses power sufficient for its purpose; but it is quite possible to construct an instrument in which either screw or hammer may be used at pleasure.

It is recommended in some, but not in all cases, before proceeding to the operation of lithotrity, to accustom the urethra to the dilatation which the presence of a large lithotritic instrument must of necessity cause. Flexible sounds, the calibre of which must be progressively increased, should be passed daily, and retained about ten minutes or a quarter of an hour upon each occasion. Malgaigne says that about eight days suffice to obtain sufficient dilatation; I am of opinion, however, that if the lithotrite, which in its present improved construction is much smaller and more manageable than those first employed, can be passed without much difficulty, it is far better for the patient that he should be left quite tranquil until the time appointed for the operation arrives; for the urethra, like other parts, will bear irritation only to a certain extent, and it never can become habituated to much violence.

The patient then having been placed on the bed, or on a common couch with the pelvis raised, the bladder is to be slowly injected with five or six ounces of lukewarm water; if any considerable quantity of the water escapes, the injection should be repeated, as the operation should never be attempted when the bladder is empty. Resistance is sometimes experienced to the injection of water, in consequence of the end of the catheter not being fully introduced into the bladder, and the eyes of the instrument being obstructed by the sides of an enlarged prostate gland. The force required to overcome this obstruction is often considerable, and occasions the patient great pain.

The French surgeons frequently use some mucilaginous decoction, as they consider it less irritating to the walls of the bladder; but I am not aware that such means possess any advantages over warm water. When the patient experiences a decided inclination to micturate, it is time to cease injecting; for the introduction of more fluid might lead to spasmodic contraction of the bladder, and to the forcible expulsion of its contents. The instruments employed for the injection of the bladder are a large sized silver catheter, with a stop-cock, and a metallic syringe, capable of holding half a pint, and of being accurately fitted to the catheter.

The catheter having been withdrawn, the lithotrite is next to be introduced; first to be used as a sound, so as to ascertain the exact situation of the calculus. There is not often any difficulty in its introduction. It is not much larger than a full-sized catheter, which, as we all know, is readily borne by the healthy urethra of an adult. The point of the instrument having reached the symphysis pubis, the handle is to be gently depressed, that the lithotrite may follow the natural curve of the urethra. There is no need of haste; the proceeding should be effected slowly, as Civiale observes, "Il faut, comme je l'ai dit ailleurs que le canal *avale* en quelque sorte l'instrument; on ne doit jamais user de violence pour obtenir l'ecartement de ses parois."

It should ever be remembered, especially by the young operator, that it is quite possible to lacerate the lining membrane of the urethra, and that this accident may occur without any great amount of force. The membranous portion of the urethra is thin, and surrounded only by a delicate stratum of muscular fibres.

The instrument being fairly in the bladder, the next step of the surgeon is to find the stone. The blades of the lithotrite being kept closed, he must first move it in a sweeping direction, with the convexity downwards, from before backwards, along the bas-fond and the posterior surface of the bladder ; then he must draw it back, the convexity being turned to the right or to the left. Thirdly, the instrument must be again pushed from before backwards to explore the side which has escaped examination. Fourthly, the point must be directed downwards to the space immediately behind the prostate, and upwards behind the symphysis pubis. The instrument should then be carefully rotated that the point may come in contact with the foreign body. In order to seize the stone, the blades of the lithotrite are to be cautiously opened, and then gently closed, the force necessary to pulverise it being obtained by turning the screw forwards. By this simple management, with a light hand, the stone is seized with facility in the great majority of cases. Otherwise we may succeed by the following method, which is especially adapted to those cases in which the bladder contains several stones of very small size :—Let the lithotrite be opened, with the convexity of its blades pressed against that part of the bladder which is towards the rectum, so as to make it the lowest or most depending situation : then, by a slight motion given to the handle of the instrument, the stones are made to roll into its grasp.

The calculus being caught, the screw must then be turned so as to secure it firmly in the grasp of the blades, and the surgeon must next satisfy himself that nothing besides the stone is included. If a doubt exists in the mind of the surgeon, he should let fall the calculus, and seize it again under different conditions. The slow propulsion of the screw soon causes the calculus to yield. Sometimes fragments only of the outer shell are detached, at other times the concretion breaks in pieces to its very centre. The screw, at first resisted, suddenly overcomes the obstacle, and makes as it were a spring forwards ; under these circumstances the calculus is very apt, particularly if hard, to drop from between the blades. Surgical instrument makers have now attained such perfection in the construction of the lithotrite, that the screw may be used without fear of breaking the blades of the instrument.

When the bladder is not irritable, the seizure of the fragments may be repeated several times, and a large part of the stone reduced to a state fit for expulsion. Before the instrument is withdrawn, or even closed, it should be moved from its situation, to ascertain that no portion of the prostate or of the mucous coat of the bladder is entangled between the blades : it is then to be closed, and, having effected its purpose, as often as required, withdrawn. In a few minutes the patient voids the water which had been injected, and with it some sand or small particles of the stone ; the larger portions remaining behind to be expelled by the bladder, which by degrees recovers its tone, and is then excited to contract with effect. The sand and smaller particles having been voided first from the bladder; then, by a more powerful action of the organ, the larger pieces are expelled. Three or four days are usually sufficient for the expulsion of the greater part of the fragments; but before another sitting takes place, sufficient time should always be allowed for the subsidence of the irritation produced by the preceding operation.

Although lithotrity is often very easily performed, it is necessary that the patient's health should be brought into a favourable condition for the operation; the same care should be taken for a few days at least both before and after it, as in other important operations. It has been too much the custom of late years to regard the operation of lithotrity as a light one, and to pay but little attention to the subsequent management of the patient. In one case in which I operated, the patient rode in a jolting vehicle from my house to Wandsworth, the consequence of which and of the operation (though it was performed without difficulty) was an attack of fever which confined the patient for some weeks. In another case, considerable hæmorrhage followed, which I attributed more to the exertion afterwards than to the operation itself. I have come, therefore, to the determination not to perform the operation of lithotrity except at the patient's house, and to keep him quiet for several days after each operation.

Mr. Lee enumerates the following conditions as occasionally supervening on the operation of lithotrity: "Retention of urine, either from the irritation caused by the arrest of fragments in the urethra; from this passage being obstructed by coagulated blood; from spasmodic action at the neck of the bladder; from atony of the bladder, or enlargement of the prostate gland; but it mostly admits of being removed by the catheter, or by the employment of antiphlogistic and sedative remedies.

"A high degree of irritability of the bladder, marked by frequent desire to make water, increase of the pain, and other symptoms. This may go on to inflammation, attended with great constitutional irritation, and a copious secretion of mucus, and is most likely to occur in young subjects, or in those of an irritable habit, where the sittings have been too much lengthened, or where the stone is exceedingly hard or of large size, requiring many sittings for its removal. The presence of sharp angular fragments of certain kinds of calculi is also a cause of cystitis in some cases.

"Cystitis is the most formidable accident to which lithotrity can give rise, and the most likely to prove fatal. A degree of chronic inflammation, however, accompanied with discharge of mucus, but without pain or much constitutional disturbance, is not unfrequently induced; this subsides after a short time by repose, and the use of appropriate remedies. In some cases where a state of chronic inflammation, with copious secretion of mucus, had previously existed, the discharge has diminished and the inflammation subsided during the treatment, by means of lithotrity, probably in consequence of the bulk of the foreign body being lessened; but whatever be the cause, experience has shown that this result not unfrequently occurs." Inflammation of the urethra may spread to other parts, to the ureter and kidney, and lead to consequences of a most formidable character. Orchitis is also a consequence of the operation of lithotrity; sometimes occurring in the course of a few days; at other times after the lapse of some weeks.

The retention of urine, which Mr. Lee attributes to spasmodic contraction at the neck of the bladder, may be caused by spasm extending along the whole length of the urethra. This part is surrounded by a structure, considered by most anatomists to be muscular, which is capable of narrowing the canal at any part, and in some cases of interfering seriously with the flow of the urine. This affection, the *retrécissement spasmodique* of the French, deserves to be borne in mind, as capable of producing very distressing symptoms. An instrument cannot be passed without severe pain, and constitutional disturbance; fragments of stone become firmly grasped along their whole course to the external meatus; and the mucous membrane becomes torn. It is in affections such as these that a full dose of opium acts so advantageously by calming the excitement and alarm of the patient.

As regards the mischief which may befal the bladder, ureters, and the kidneys, in consequence of lithotrity, it has been often observed that in incipient disease of the kidney this evil is very likely to gain ascendancy during the period of treatment, caused by irritation, either of the instrument or of the stone when broken in the bladder. Cases occur in which the crushing has been easily performed, but where the escape of detritus is very small. Inflammation of the bladder supervenes, which destroys the patient, and examination discloses a sacculated condition of the organ, into the diverticula of which the fragments of the stone are collected.

Hæmorrhage is a common occurrence, though rarely to such an amount as to give cause for uneasiness; it is, however, surprising how long blood will continue to exude. There are some subjects in whom an abnormal development of the capillary vessels disposes the mucous membrane of the bladder, under the influence of the least irritation, to exude a quantity of blood, which is never sufficiently considerable to inspire alarm, but which sometimes suffices to form clots, the presence of which renders it difficult to pass the urine, and complicate the case. Rest, the recumbent posture, and the application of cold are generally sufficient to arrest the bleeding. Acetate of lead, or gallic acid with opium, may be administered with advantage in such cases.

In lithotrity, the walls of the bladder have been perforated even by skilful operators. The bladder is in these cases usually in a morbid state; the coats are thin and softened, and offer but little resistance to the instrument. Such an occurrence is, from all experience, invariably fatal, peritonitis ensuing from effusion of urine into the abdominal cavity. Peritonitis, however, may ensue from other causes. The bladder becomes inflamed; the morbid action spreads to the peritoneum, in which a sub-acute form of the disease is set up, characterised by a frequent wiry state of the pulse, tympanitic state of the belly, difficult micturition, and typhoid symptoms. The usual remedies in peritonitis may be tried, but the condition of the patient is such as generally to forbid active depletion.

The patient often suffers severely from the lodgment of fragments of stone in the urethra. Complete retention may ensue, until the cause of obstruction be removed. The treatment varies; either the stone may be extracted by means of the urethral forceps; or an incision may be made into the urethra over the fragments from without. Although the latter operation should never be hastily performed, it is better than tearing the corpus spongiosum and its mucous membrane by the forcible extraction of a sharp and angular body.

The state of the prostate has great influence on the degree of facility with which lithotrity may be performed. This gland is situated chiefly under the neck of the bladder, which it sometimes completely envelops, forming a kind of furrow, in which the commencement of the urethra and the neck of the bladder are lodged. It is evident that the difference in the size and form of the gland will have especial influence on the canal with which it is so closely connected. The state of this gland ought then to be particularly examined, when considering the propriety of performing lithotrity.

A simple mucous catarrh of the bladder is not a valid objection to this operation; but when the discharge is muco-purulent, and attended with an hæmorrhagic disposition, the operation ought not to be undertaken.

Another cause which renders lithotrity difficult, is the great degree of contractility which the bladder manifests in some subjects. The first step in such cases is to reduce the state of increased sensibility by appropriate treatment—rest, gentle aperients, anodyne glysters, &c., and then to proceed to the operation.

LITHOTOMY AND LITHOTRITY.

In this country but few data exist from which we can draw accurate conclusions on the relative merits of lithotomy and lithotrity.

M. Velpeau has published an analysis of the cases of M. Civiale, the most experienced lithotritist of the present day, which are arranged in five series.

Series.	Number of Cases.	Cured.	Dead.	Unrelieved, the stone remaining.	Otherwise,	
					Success in	Failure in
1st.	83	41	39	3	41	42
2nd.	24	13	11	0	13	11
3rd.	53	30	15	8	30	23
4th.	30	18	8	4	18	12
5th.	16	6	7	3	6	10
	206	108	80	18	108	98

That is to say, of 206 patients operated upon, 108 (a very little more than one in two) recover immediately; 80, or nearly one in two and a half, die; and 13 retain the stone, and will be lost;—108 cases cured, to 98 in which death is immediately induced or may not be averted within a brief interval of time. M. Civiale has, however, since published an account of his own cases, which differs most materially from the above statement.

Of 303 patients, says M. Civiale, who underwent lithotrity, 296 were cured, and seven died; of these only six were under my treatment, for M. Arnoux, who figures in this table, and in that of the relapses, was not operated upon by me a second time; three only were imperfectly relieved—they continued to suffer, in truth much less, and in a different way; but without the power to determine the cause of their suffering—the result remains unknown. All the patients in the two first lists (namely), simple cases, in which the stone measured 3 to 7 lines in diameter, or from 8 to 12 lines in diameter, were cured. In the third list (the stone measuring 12 to 16 lines in diameter, there being superficial organic lesions, or important lesions with a small stone, general health altered) there was one death. In the fourth (the stone measuring 16 to 20 lines diameter, or calculi very numerous; lesions in the tissues and in the functions of the bladder or prostate; general health good) there was one incomplete cure. In the fifth (general health bad, lesion of organs essential to life) there were four deaths and one incomplete cure. In the sixth (the stone above 20 lines diameter, or in great numbers; treatment very long) there were two deaths, one incomplete cure, and one result unknown. In comparing with regard to age, the calculous patients who have undergone lithotrity, M. Civiale finds—

9	from 7 to 20 years.
55	from 20 to 40 years.
105	from 40 to 60 years.
138	from 60 to 80 years.

The mean term of the duration of treatment was—

For patients of the first class .	11 days.
Of the second . .	26
Of the third . . .	35
Of the fourth . . .	56
Of the fifth . . .	56
Of the sixth . . .	63

The average duration of treatment in each case was, therefore, a little more than 41 days.

After reviewing the circumstances connected both with lithotomy and lithotrity, Mr. Lee draws the following conclusions, in which I mainly concur :—

I. That lithotomy is still, in the present state of the art, the operation most suited to the majority of cases of stone in the bladder, inasmuch as about one-half of the number of stone patients consists of children, to whom, with few exceptions, it is more particularly adapted.

II. That, as far as adults and elderly persons are concerned, lithotrity is most applicable to an equal, if not to the greater number of cases.

III. Lithotrity is preferable in the great majority of female patients.

IV. Other circumstances being favourable, lithotrity is more especially suited to calculi of small size, even when hard.

V. Lithotrity is less applicable than lithotomy to most cases, where the bladder contains several calculi, especially if they be hard.

VI. Lithotomy is the preferable, and often the only admissible operation, in cases of large calculi ; as also in those cases where the stone, though only of moderate size, is yet of considerable density, and irregular on its surface, as in the oxalate of lime variety.

VII. When there exists much irritability of the urethra and bladder, which cannot be allayed by preparatory treatment, lithotomy would be the preferable operation ; especially if the irritability appeared to be chiefly dependent upon the presence of the stone.

VIII. Lithotrity is applicable in some cases of deranged health, or disease of parts, which would contra-indicate lithotomy, or would render its performance most likely to be attended with failure.

IX. The degree of pain from the performance of lithotrity is not great in many cases, and is mostly diminished after the first sittings; but, on the other hand, in some instances, the operation is very painful, and the pain becomes increased in subsequent sittings; though, perhaps, never so acute in lithotrity as in lithotomy, yet as the pain in the latter operation lasts only for a few minutes, whereas in the former it recurs, though less in degree, on each sitting, the patient frequently suffers by lithotrity a greater amount of pain.*

X. The duration of the treatment is generally longer by lithotrity than by lithotomy, though sometimes it is shorter; and after the stone has been removed by the latter operation, the patient, though confined to his bed, may, during the greatest part of the period, be considered as convalescent; whereas, when lithotrity is performed, there is always a risk, so long as any fragments remain in the bladder, of circumstances arising to prevent the completion of the operation, and the patient cannot be regarded as out of danger.

XI. When lithotrity is applicable, the method by pressure is, in the great majority of cases, infinitely superior to that by percussion.

XII. Lithotrity exposes more to the risk of a relapse than lithotomy, on account of the great probability of a portion of stone having escaped detection, and remaining in the bladder after the operation.

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* The use of chloroform in surgical operations very much modifies these observations.

SOLUTION OF STONE.

Various attempts have been made to dissolve stone in the bladder, sometimes by internal remedies, administered by the mouth, at other times by chemical agents thrown directly into the bladder.

Fourcroy and Vauquelin first laid down rules for the selection of those remedies which would exert the most favourable chemical action. The uric acid calculus was to be dissolved by the diluted alkalies; the phosphatic by the diluted hydrochloric acid; the oxalate of lime by the diluted nitric acid.

Mrs. Stephens acquired a great reputation for discovering a remedy which was supposed to dissolve stone in the bladder, and for which she received a large sum from the government. Many cases were recorded in which it was stated to work marvels, not only by dissolving the stone, but also by removing various unpleasant and distressing symptoms connected with renal and vesical diseases. As is now well known, it was found to consist of Castile soap and egg-shells.

Dr. White, of Edinburgh, relates the following case in a small work entitled "Essay on the Virtues of Lime Water and Soap in the cure of Stone." "David Miller had long been the subject of stone in the bladder, which had caused him the most excruciating sufferings. After trying a great variety of medicines, he took Castile soap, to the amount of an ounce and a half daily, washed down with three pints of lime water. He soon experienced great relief, and after passing several fragments of stone, was considered cured. When he died, at the end of eleven years, no stone was discovered."

The mineral waters of Vichy have been tried as solvents for stone, and it seems also undeniable that in several persons in whose bladders the presence of calculi had been ascertained by sounding, the symptoms were relieved or removed, while using the water internally.

M. Chevallier was the first who instituted direct experiments on the powers of the alkaline water of Vichy, to dissolve and disintegrate urinary calculi. The following are the particulars of some of his trials :—

1. A quantity of lithic acid gravel was subjected to the action of the Vichy water, kept at a temperature of 97° F. The concretions were speedily destroyed; the lithic acid being entirely dissolved, and nothing remaining suspended in the fluid but a few loose flocculi of animal matter.

2. The half of a lithic acid calculus, weighing 1 ounce, 1 drachm, 36½ grains, was placed in a little bag of wire muslin, and subjected to the action of the Vichy water * during 151 hours : dried carefully and weighed after this, the calculus was found reduced 2 drachms

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* There are seven principal springs which pour out these waters, the product of each differing but little from that of the rest. The composition is as follows :—

Water . . .	from 991·9	to 994·9
Carbonic acid gas . .	1·2	0·93
Carbonate of soda . .	5·5	4·7
Carbonate of lime . .	0·6	0·3
Carbonate of magnesia .	00·9	00·6
Muriate of soda . .	0·47	0·52
Sulphate of soda . .	0·47	0·27
Silicia . . .	0·04	0·04

52 grains ; so that in less than a week it had actually lost 6 drachms, 47 grains, or more than two-thirds of its original weight.

3. In another experiment, five calculi, one of phosphate of lime, weighing 1 drachm, 18 grains ; a second of lithic acid, weighing 1 drachm, 8 grains ; a third of lithic acid, weighing 25 grains; a fourth and fifth, fragments of phosphatic calculi, weighing, the one 29 grains, and the other 13 grains, were enclosed together in a bag of wire muslin, and exposed, on the 5th September, to a constant stream of the Vichy water, of the temperature of about 98° F. On the 11th September, the bag being examined, was found completely empty ; the calculi of lithic acid had been dissolved, those of the phosphates disintegrated, and their particles washed through the meshes of the muslin.

Contrary to the usually entertained opinion, M. Petit found that, on the whole, calculi of the triple phosphate of ammonia and magnesia lost most under the action of the Vichy water, i. e. of a solution of bicarbonate of soda in water supersaturated with carbonic acid, than those of the lithic acid. For example : five specimens of lithic acid calculi, weighing together a little more than 118 grammes, after remaining, on an average, twenty-seven days exposed to the action of the water, lost very near 64 grammes, or 53 per cent. of their original weight ; but five specimens of the ammoniaco-magnesian phosphatic calculus, which, together, weighed rather more than 97 and a half grammes, and only remained under the action of the water, one with another, for the space of twenty-three days, lost fifty-eight grammes and three-fourths, or 60 per cent. of their original weight.

M. Petit, like M. Chevallier, found that the Vichy water had extremely little influence on calculi composed of oxalate and phosphate of lime. This water, however, would dissolve cystine and xanthic oxide calculi, with at least as much readiness as it disintegrates and dissolves those of lithic acid and the triple phosphate. Water surcharged with carbonic acid, and holding a little bicarbonate of soda in solution, is consequently a solvent for the calculi of every description that are of somewhat frequent occurrence, save those of the oxalate of lime. Such a water will therefore attack something like nineteen-twentieths of all the known varieties of urinary concretions.

The destruction of urinary calculi by an alkaline water is found to be, not merely, nor perhaps even principally, by way of solution ; it is accomplished in a very considerable degree, especially as regards those of the triple phosphate, by a kind of disintegration of their component particles. When calculi which consist principally of the oxalate or phosphate of lime are mingled with a little lithic acid, lithate of ammonia, or triple phosphate, which they are very frequently, the alkaline water attacks and disintegrates them rapidly, so that the sphere of its activity is still further extended.

The experiments, however, conducted by Peloreze and related in vol. xiv. of the *Comptus Rendus* of the Academy of Sciences, lead him to the following conclusions, which fully account for the decided want of success which has attended the use of solvents.

I. The effects of different agents upon urinary calculi proceed very slowly, and is chiefly upon the animal matter which enters into their composition.

II. Drinks and baths never effect a cure.

III. The result of injections is problematical, and the danger of inflammation not counterbalanced as in lithotrity, by a rapid destruction of the calculus.

IV. Although the combination of lithotrity with injections increase the probability of success, yet it is most advisable to proceed with lithotrity.

Dr. Hales endeavoured to prove by experiments that fluids, injected into the bladder by the urethra, were capable of diminishing the size of a vesical calculus. He invented a double catheter, which he used for washing out the bladder, and compared the fluid injected with that expelled after contact with the stone.

Dr. William Butler, of Edinburgh, instituted in 1752, a series of experiments with lime water, and soon after a case occurred in the practice of Dr. Rutherford, which was reported to be attended with complete success.

In the "London Journal of Medicine" for October, 1851, there is an extremely interesting paper by Dr. Hoskins of Guernsey, on the introduction of solutions of lead into the bladder for the decomposition of phosphatic calculi.

The adaptation of the principle of double decomposition to the disintegration of vesical calculus is in strict accordance with chemical usage ; it supplies, says Dr. Hoskins, a class of agents, more energetic as regards the concretion, and less injurious to the organ in which it is contained, than any of the uncombined solvents hitherto employed. The solvent, no matter how dilute, can only be tolerated for a minute or two at furthest, and cannot soon be repeated ; the decomponent, on the contrary, is retained from ten to fifty minutes without discomfort, and may be repeated daily or oftener if necessary. The cause of this difference is sufficiently obvious ; the active agent of the decomponent is liberated gradually, and neutralised by the earthy bases of the calculus before it can come in contact with the living tissues ; whereas the former class of fluids causes such immediate irritation, that their ejection is required before any impression can be made on the concretion. The *base* of the decomponent unites with the *acid* of the calculus, while the acids of the former combine and form soluble salts with the bases of the latter. The combined acids are set free in definite proportions, neutralised in their nascent state, and removed from the sphere of action before any stimulating effects can be exerted on the bladder.

Cases under the care of Mr. Guthrie, the late Mr. Aston Key, Mr. Copeland, and myself are recorded in this communication. On one occasion the rejected fluid contained eighteen grains of dry phosphate of lead.

Dr. H. recommends the nitro-saccharate of lead for the purpose now under consideration. One grain of the salt, superacidulated with five drops of strong acetic acid is the proper proportion of admixture with each fluid ounce of water. It is essential that the salt and the acid should be incorporated before the addition of the water, and that the whole should be brought to the boiling point. Superacidulation is necessary on many accounts ; it secures perfect solution, increases the decomposing activity of the liquid, and prevents the formation of any carbonate of lead.

As the salts in the urine tend to decompose the solution, and lessen its effects on the concretion, the bladder should be evacuated, and washed out with tepid water before the lead fluid is introduced. A double-current caoutchouc catheter is the best for this purpose, as it enables a continuous stream to be employed; and as, on account of its flexibility, it is less liable to irritate the urethra, which should be sedulously avoided. From four to eight fluid ounces of the solution may be thrown into the bladder at a time, and renewed every ten or fifteen minutes, as often as may be deemed proper. By renewing the liquid at short intervals, much greater effect on the calculus is ensured, than when it is allowed to remain longer; for the precipitate formed by the decomposition soon envelops the stone, and puts a stop to further action, until a fresh surface is exposed. Exercise during the retention of the injection increases its effect. Some slight revulsion may be produced by the first introduction of this or any other fluid into the bladder; when such is the case, the operation should be remitted for a day or two, and cautiously renewed. The injection may be either warm or cold, as may be most agreeable to the sensations of the patient. Warmth favours the decomposition of the calculus.

Besides the kind of cases already adduced, Dr. Hoskins thinks there is one variety for which decomponents seem to be peculiarly adapted, viz. concretions in the prostate gland. No instrument hitherto devised has been successful in dislodging them. The first case, however, mentioned in the author's paper goes to prove that a considerable quantity of calcareous matter was removed from the prostatic portion of the urethra by the use of the lead injection.

FOREIGN BODIES IN THE BLADDER.

THE number of foreign bodies, besides proper urinary calculi, which have been found in the bladder, is immense. Both in males and females, hair, beans and peas, fruit-stones, ears of corn, portions of bougies, nails, bullets, small bones, pins, needles, string, stalks of flowers, &c. &c., have all been extracted from the bladder; these foreign bodies having frequently formed the nucleus of a stone.*

Several instances of hair voided by urine are mentioned by Sir Hans Sloane: one particularly of a brewer, who suffered from the occasional passage of long hairs, matted or woven together, passed with great pain, but with little or no calculous matter attached to them. Mr. Powell relates a case of a middle-aged lady, who, after being teased with disordered stomach and bowels, and evacuation of whey-coloured and fœtid urine, passed little masses of hair, mingled with a peculiar viscid mucous substance, partially crusted with calculous matter. The excretion of these masses was attended with aggravation of the distress and pain in the bladder, from the urine bringing them into contact with the orifice of the urethra. The complaint, which in this case continued long, induced great weakness and much wasting of the body. Dr. Wallace also met with an instance, in which hair was several times voided with the urine; and on the body being examined after death, a stone was found in the bladder, large as a goose's egg, from parts of which hairs had grown out. It was thought that the hairs voided during life, which were a great many, and some of an extraordinary length, grew out of that stone; because when the hairs hung out of the urethra, as they frequently did to the great torment of the patient, they were obliged to be pulled out, which was always done, with a resistance, as if plucked by the root. (*Howship*, op. cit. p. 167.)

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* I would refer the curious on this subject to the "Dictionniare des Sciences Médicales," t. vii. p. 38.

Musket-balls have found their way into the bladder, sometimes occasioning very little inconvenience, at other times giving rise to very distressing symptoms. Larrey, Ballingall, and other writers, mention cases of this kind. The presence of these bodies in the bladder is indicated by pain, more or less acute, weight in the perineum, tenesmus, dysury, stranguary, and bloody urine.

Mr. Toogood, of Bridgewater, has published in the "Medical Gazette" two interesting cases, where a female catheter slipped into the urethra. In both cases, the instruments were extracted by dilating the urethra by the sponge tent, so as to enable the forefinger to be introduced into the bladder.

About two years ago I was summoned to a case in which a female catheter had slipped into the bladder, and after an hour's trial with various instruments, I at last succeeded in laying hold of it with a long straight narrow forceps and withdrawing it. The late Mr. Key and myself saw, some years ago, a case, where three inches of a thin gum elastic catheter broke in the urethra, near to the bladder, and, although we were called to the gentleman immediately after the occurrence of the accident, we could not lay hold of the broken portion. Three weeks after this, the fragments (for there were two, one an inch in length, and the other two inches) were voided by the urethra.

If the body is small, and so situated in the bladder that one of its extremities rests in the neck of this organ, or in the canal of the urethra, it may be expelled by the urine a short time after its introduction, and before it becomes coated with much saline matter. If the foreign body be not passed by the urethra, efforts should be made to remove it by means of Weiss' instrument for extracting small calculi. Hunter and Desault invented forceps for extracting foreign bodies from the urethra; but Bichat states that he had never succeeded in any attempt to remove from the dead body portions of bougies inserted into the bladder. Of late years, however, since the improvement of vesical instruments, the operation has been repeatedly performed with success.

Hydatids have been discharged from the urethra, and after death numbers of them have been found floating loose in the bladder. In such cases, it is most probable that they have descended from the kidney along the ureters, or that they have been introduced into it from a cyst formed in the pelvis, which had opened by ulceration into the bladder. Worms also have been discharged with the urine; an instance of which is related by Mr. Lawrence in the "Medico-Chirurgical Transactions."

Mr. Curling (*Med. Chir. Trans.*, vol. xxii.) has given an account of some worms which he discovered in the urine, and which do not appear to have been before described. The urine in which the worms were contained was high-coloured and slightly acid. It was observed that when first passed they floated separately in the urine, but in a short time they coalesced and coiled themselves up together in the form of a ball, at the bottom of the vessel, and it was with difficulty that they could be separated. When they were disturbed, their motions were often very lively; and if allowed to remain in the urine they lived for two or three days. They were very transparent, so that the contents of the alimentary canal could easily be distinguished by the naked eye. On immersing them in spirits of wine they soon became white and opaque. They were of two sizes; the larger worms being more numerous than the smaller.

A slight examination at once convinced Mr. C. that these worms could not belong to any of the species of entozoa at present known to infest man; and considering the period of the year, he was at first induced to imagine that they must have been the larva of some insect. On placing one in the field of a microscope, he recognised a beautiful organization, and true nematoid structure, and on reference to Rudolphi's "Synopsis Entozoorum," and other works on this subject, discovered that it was an entozoon, which had not hitherto been described.

CHAPTER XIX.

ACUTE INFLAMMATION OF THE PROSTATE GLAND.

The prostate gland, one of the most important accessory secreting organs in connexion with the generative system, is situated at the neck of the bladder, surrounds the urethra, and receives the termination of the ejaculatory ducts ; it is a firm fibrous structure containing a yellowish white spot, or cavity analogous to the uterus of the female (uterus masculinus). The two lateral lobes, with their connecting central portion, consist of a fibrous capsule, derived from the deep pelvic fascia, and of a yellowish gray structure composed of flat muscular fibres which penetrate into the substance of the organ, forming its greater part ; the true glandular structure, amounts, according to Kölliker, to only one-third of the whole. In this network are contained the vesicles which secrete the prostatic fluid, about twelve or fifteen of which unite to constitute a lobule, giving off a single duct, which opens, independently of the others, into the urethra. The prostatic ducts are more numerous than have been supposed, but from their extreme tenuity, and from the fact that they can be only momentarily seen when the secretion is being squeezed from them, their exact number is perhaps uncertain. The microscopical structure of the prostate bears some resemblance, according to Henle, to the salivary glands ; and I may here observe that Cowper's glands possess a very analogous structure. The prostate is always small when the organs of generation are in an imperfect state ; and it is subject to the same law of development which regulates the formation of the bladder or penis.

This gland, in common with every other part of the body, is subject to inflammation, which may be either of an acute or chronic kind. In the acute form, there is heat and pain in the perineum, extending towards the anus ; frequent micturition ; and scalding in making water, which is increased as the acceleratores urinæ contract to expel the last drops of urine. Evacuations from the bowels also cause great uneasiness, and there often remains a sensation as if the rectum was not completely emptied, giving rise to distressing tenesmus. If the finger be introduced into the rectum, the gut is felt hot, and the prostate seems a smooth, round, and hard body, projecting downward on the bowel, and exceedingly painful to the patient under pressure of the finger.

The inflammatory action, if not checked, shortly extends to the neck of the bladder, and, not unfrequently, to its whole inner lining ; then total retention of urine frequently succeeds, intense febrile symptoms supervene, accompanied with delirium ; and in this stage the patient may die, if the bladder be not relieved, and the inflammation subdued.

When rigors occur, with increase of febrile symptoms, quickened pulse, hot skin, furred tongue, &c., as well as with greater sense of fulness and tension in the perineum, more frequent calls for, and greater difficulty of micturating, it is most likely that suppuration is taking place. If at this period we examine the prostate through the rectum, we shall no longer find it hard and resisting, but on the contrary, it will be found to so greatly resemble the bladder, that inexperienced persons would most likely be led into error ; the examination per rectum, as well as the discharge of fæces, causes great pain : and there is constant tenesmus, with a burning sensation in the part.

The fibrous investment of the prostate, softened by inflammation and distended by pus, bursts and allows the escape of a creamy and sanguineous matter into the urethra, the rectum, or the bladder : then the tumour diminishes, the urethra becomes free, the urine flows in a large stream, and as the bladder empties itself, the patient feels his sufferings decrease.

If the abscess opens into the urethra, a very copious purulent discharge instantly manifests itself from this passage : the urinary discharge is accompanied, but more frequently preceded or followed, by the evacuation of a large quantity of purulent matter, the specific gravity of which is much greater than that of the urine and the vesico-prostatic mucous products. After the last drops of urine are voided, there is a stinging pain which lasts for a few minutes, or for a much longer period, according to circumstances. There is in some cases more or less blood mixed with the discharge, and I have known considerable hæmorrhage take place. There is also pain in the glans penis, as if a burning coal was applied to it. (*Home on Diseases of the Prostate Gland*, vol. i., p. 225.)

Authors relate cases in which a single abscess in the prostate contained half an ounce or more of pus, such a case is mentioned by Petit; but more commonly the abscesses are of smaller size, and so numerous that after death the prostate presents a sieve-like appearance from their number and minuteness. When the abscess is of long standing, the pus is contained in smooth organized cysts, and extremely fœtid. In other cases the fluid is of a light straw-colour, and of a cream-like consistency; with it is mixed some of the debris of the gland, and occasionally blood. The surrounding textures are softened, infiltrated by serum, and of reddish hue. They may be almost disorganized, and converted into a substance not unlike wet tow.

The abscesses, if unopened, make their way into the rectum, the bladder, or the urethra. They may involve, in the latter situation, the opening of the ejaculatory ducts, which would then be destroyed.

The matter is discharged mixed with the natural contents of these viscera, and the urine deposits pus in the form of sediment. But the abscess may burst into the peritoneal cavity at the posterior part of the prostate, and so cause fatal inflammation. The occurrence is marked by acute pain in the pelvic region, small pulse, rigors, and rapid prostration of strength.

The pressure made by vesical calculi on the neck of the bladder, the constant irritation kept up by their presence which, by the continuity of mucous tissue, is so readily transmitted to the prostatic portion of the urethra—act as predisposing causes to inflammation of the prostate itself. Of the same nature are the morbid secretions proceeding from vesical catarrh, or from a diseased kidney, which directly or indirectly act upon the prostate, and excite inflammation either in its follicles, or in the cellular tissue that envelops them.

Another common cause of this inflammation is an old stricture in the urethra, and it rarely happens that the obstacle it presents to the free flow of urine, does not produce inflammatory affections in the prostate, the intensity of which is usually in relation to the degree and extent of the constriction.

During the existence of a gonorrhœa, prostatic inflammation not unfrequently occurs. In this case, the discharge diminishes, or nearly ceases, as soon as the gland becomes inflamed, and the pain which was confined to the anterior part of the urethra is referred to the perineum, accompanied by a disagreeable sense of fulness and tenderness, increased by standing or sitting.

The internal use of the gum-resins and astringent injections employed in the treatment of gonorrhœa, are among the exciting causes of prostatitis.

Small calculi proceeding from the bladder, lodging among the prostatic lacunæ, and those concretions that not unfrequently form in the same situation, likewise produce prostatitis.

As the prostate partakes of the excitement of the venereal orgasm in sexual intercourse, we can easily conceive how excessive venery may be an occasional cause of the same affection.

Exposure to wet, particularly of the feet, or the immersion of the feet in cold water, especially in rheumatic subjects, is apt, where there is predisposition to the disease, to produce acute inflammation of the prostate.

Too nutritious and highly-seasoned viands, and the excessive use of vinous and spirituous liquors, can sometimes be traced as giving rise to prostatic inflammation.

The French writers on this disease impute its occurrence occasionally to the use of strong coffee as a refreshment.

Cantharides are well known as inflammatory excitants of the genito-urinary system, whether employed externally or internally, and often set up inflammation in the prostate.

Persons who are obliged to travel much on horseback are often the subject of prostatitis, which is occasioned by the constant friction and concussions to which the perineum is exposed.

This disease very often affects those of opposite pursuits,—the man who sits for a long time in his counting-house, and the student who too often neglects to obey the call to stool, or to satisfy the natural desire to empty the bladder.

Worms situated in the lower bowel have been observed at times to cause considerable irritation in the prostate, which is allayed only by the expulsion of those entozoa. But besides worms, other causes which keep up a continual irritation in the rectum are capable of exciting inflammatory action in the prostate, such as habitual and obstinate constipation. The same cause will also produce a varicose state of its veins, as well as of those of the extremity of the rectum. During the efforts of defecation, the venous blood, being forced to the bottom of the pelvis, distends the veins and makes them varicose; and thus the prostate is increased in bulk, independently of any lesion of its tissue.

The abuse of those purgative medicines which act principally on the rectum, as, for instance, aloes, will give rise to disease of the prostate. In cases of dysentery also, in which there is much congestion of the rectum, the prostate may become inflamed from continuity.

Sir E. Home considered the disease as entirely local, produced by local violence, kept up by local circumstances, and having all its symptoms aggravated by a succession of causes of irritation belonging to the organs to which the prostate gland is attached.

When, through active and appropriate treatment, acute inflammation of the prostate terminates in resolution, all the symptoms above indicated diminish; at the same time, the liquid secreted by the follicles of the gland augments in quantity, and, mixing with the urine, in the form of a whitish or grayish viscid matter, settles at the bottom of the vessel without adhering to its sides, having very much the appearance of imperfectly elaborated pus. This matter diminishes in its turn, and finally disappears, as the functions of the affected parts return to their healthy and natural condition.

Acute prostatitis demands the employment of the most active antiphlogistic treatment.

If the attack is severe, blood may be taken, by cupping, from the loins or perineum. Leeches, moreover, may be applied above the pubes, particularly when pain is experienced there, or in the perineum. The French practitioners recommend the application of leeches on the rectal surface of the prostate, by means of a speculum introduced into the anus.

Mr. Wm. Craig (*Lancet*, vol. ii., Session 40—41, p. 299—300) relates a case of diseased prostate in which he employed a particular method of applying leeches directly to the gland, differing both from those of Henderson and Bejin. It consists of a tube into which is fitted a piece of wood, with a handle at one end, while the other terminates conically in a blunt point, for the purpose of gradually dilating the rectum. When this is effected, the wooden dilator is to be withdrawn, and a box of proper size to fit the tube, and capable of holding three or four leeches, with a piece of wire to form a handle fixed into the bottom of it, is to be pushed through the tube.

It is necessary to lubricate the wood and the tube with oil previous to using it, and in introducing it, it should be directed towards the rectum in order to prevent its coming in contact with the tender prostate.

In elderly persons, the efficacy of taking blood is more doubtful, and the relief obtained by it is only temporary.

After depletion, morphia allays irritation, and assists in removing inflammation. Its preparations may be given internally, or may be used per rectum, and repeated so as to subdue irritation, its constipating effects being occasionally obviated by a previous enema of hot water, and by small doses of gentle aperients. "If, in defiance of these means," says Sir E. Home, (*Diseases of the Prostate Gland*, vol. ii., p. 92,) "the patient is unable to make any water, or although able to pass a few ounces, is every hour obliged to make the attempt, and, with much straining, does no more than void the same quantity, such symptoms are most undoubtedly not to be allowed to go on, since by their continuance, they are establishing a complaint which, if the symptoms are arrested in their progress, will get well. A flexible gum catheter should be passed without a stilet, in the most skilful manner, into the bladder, the smallest degree of violence being used that is consistent with the nature of the operation; and when the bladder is emptied, the instrument should be retained in the bladder, the water being drawn off at regular intervals, not only till the first symptoms go off, but till the bladder can retain the water for the usual length of time, and the water, when voided, has the appearance of healthy urine. The means to be employed in preventing and assuaging pain are Dover's powder in different quantities, according to the urgency of the symptoms, and opiate glysters. As soon as the parts have recovered themselves, the catheter is to be withdrawn, and there is every reason to believe it will not be necessary to introduce it again on the present occasion."

Hot bathing generally, as well as locally, gives relief.

Febrile symptoms and constitutional derangement must be attended to, by withholding food, and permitting the use only of bland and diluent drinks.

If a catheter or sound be introduced into the bladder, it passes without difficulty or uneasiness as far as the membranous part of the urethra ; but its passage through the prostatic portion of this canal is attended with most acute pain, and accompanied with severe spasmodic contractions. All the above symptoms are much aggravated in the sitting or standing position, by violent exercise or fatigue of any kind. Beer, coffee, and spirits should be refrained from, and exposure to cold or damp, or any sudden change of temperature as much as possible avoided.

If an abscess forms it is desirable that the matter should find its way neither into the rectum, the urethra, nor behind the bladder, which may be fatal, but should pass to the surface, in order to discharge its contents more freely, and heal more readily. We must not, therefore, hesitate, when fluctuation can be discovered, to make a puncture with a lancet, without waiting for the matter to present at the surface.

Should the disease have anticipated the operator, and the abscess have opened into the perineum or the rectum, nothing can be done beyond maintaining the general health. Should the abscess have burst into the urethra, or at the neck of the bladder, it might be better to allow a flexible catheter to be retained in the canal, until there is reason to believe the abscess is healed, than to practise its frequent introduction. Most commonly the matter gradually diminishes in quantity, and ceases after a time. In other instances the discharge disappears for a time, and then comes on, and this may occur several times before the patient completely recovers.

In these cases, ulceration of the surface of that portion of the prostate which projects into the bladder sometimes occurs. In this state, or even in that of mere enlargement, the gland is liable to bleed. This usually will cease by antiphlogistic treatment, and by keeping the patient entirely in the recumbent position.

CHAPTER XX.

CHRONIC ENLARGEMENT OF THE PROSTATE GLAND.

THE most common affection of the prostate is chronic hypertrophy, which may involve the whole, or only part of the organ, producing changes in the neck of the bladder and in the urethra which interfere with the power of the patient to expel the urine. This change was formerly considered to ensue from chronic inflammation; and Verdier (*Obs. sur les Phlegmasies de la Prostate*), who in common with many other French authors entertains this opinion, believes that frequently an attack of acute inflammation in the organ, partially subdued, and not totally extinguished by the treatment which has been adopted, leads to a state of engorgement, which, either spontaneously or through some accidental excitement, resumes that action known, in its abated form, as chronic inflammation.

However, if we carefully examine the gland, we fail in detecting any of those changes commonly known as inflammatory, such as the effusion and organization of lymph, by which the component parts become glued together, and rendered indistinct from one another. The structure appears to be but little altered; it may be rather harder or softer than natural, generally the former; the ducts may be dilated and full of secretion; or the whole gland may be coriaceous without other visible change. This change in the condition of the prostate takes place slowly, and at first imperceptibly, and the term chronic enlargement is not improperly employed to distinguish it from the inflammatory attacks to which the organ is liable. It is erroneous, however, to suppose that in a state of health the prostate gland becomes enlarged with advancing years. On the contrary, if no morbid change is going on, the prostate gland, like other parts of the body, decreases in size.

In some cases the gland is only slightly enlarged; in others, it attains the size of a man's fist. Bartholin relates a case in which the gland is said to have equalled in size a man's head; this statement, however, is clearly loose and exaggerated. The parts most frequently affected are the lateral lobes, which from their proximity to the urethra, influence very materially the length, the direction, and the diameter of the canal. The increase is chiefly in the long axis of the organ, so that the lateral lobes become oval and elongated, and larger in the middle than at the extremities. They may project inwards to such a degree as to touch one another; or more commonly there is a median groove or gutter left between them. When the enlargement affects the glandular substance in its entire circumference, the urethra is flattened and contracted; if one lobe is more enlarged than the other, the urethra deviates to the opposite side. This lateral bend or obliquity in the passage will increase the difficulty in passing the urine, and in introducing the catheter. It has been observed, that the left lobe of the gland increases more rapidly and to a greater extent than the right, therefore throwing the lateral bend more frequently towards the right side; the left lobe also frequently projects more than the right towards the cavity of the bladder. Sir Everard Home, who first noticed this circumstance, says, that he is unable to determine whether it arises from any peculiarity in the left lobe, or is only accidental; but it is deserving of notice, that he had, when he published his first volume on the diseases of the prostate gland, never met with the same circumstance in the right lobe. An acquaintance with this fact may be of use in cases where difficulty occurs in passing the catheter, as it enables us sometimes to give the proper direction laterally to the point of the instrument. In the second volume, however, which was published in 1818, Sir Everard gives an engraving, in which the right lobe of the prostate formed the largest projection towards the cavity of the bladder. He mentions that in two instances he had seen a similar enlargement of the right lateral lobe. I have also more than once met with this greater enlargement of the right lobe. Sir Everard has very properly observed, that the knowledge of this will induce the surgeon, after trying gently first on the left side, to go immediately to the right, without persevering in farther trials on the left side.

Cases occur in which the prostate gland presents an irregular knobbed appearance, the elevation projecting towards the bladder, or pressing against the rectum. Upon division of the organ I have found fibrous tumours imbedded in the interior, and closely interwoven with its texture, as we have often opportunities of witnessing in the uterus. With the enlargement of the gland itself they become more prominent, and then, the base and neck bearing a less relation to the entire bulk, they appear pedunculated. These elevated portions of the gland, or fibrous tumours as they may be called, have been known to be completely separated from their base by the incision in the operation of lithotomy, and the surgeon withdraws in the forceps a red fleshy mass often of considerable magnitude. The patient is a gainer by the loss since they have been known completely to block up the vesical orifice of the urethra.

Enlargement, however, of that part of the gland which, since the days of Home, has been called the middle lobe, is the most important from the impediment which it offers to the discharge of urine. It is often remarkably developed in general hypertrophy of the entire gland. Commencing in the form of a nipple, under the mucous membrane, which is pushed before it so as to be put on the stretch, it encroaches upon the vesical cavity in the direction from the urethra to the verumontanum. In its further increase, observes Sir E. Home, it loses the nipple-like appearance, becoming broader from side to side, and forms a transverse fold by pushing forward the membrane, connecting it to the lateral lobes, which also become proportionally extended.

As the tumour and the transverse fold are situated immediately behind the orifice of the urethra, they are pushed forwards before the urine in every attempt that is made to void it, acting like a valve and closing up the opening till the cavity of the bladder is very much distended; then the anterior part of the bladder being pushed forward, and the tumour drawn back, in consequence of the membrane of the posterior part of the bladder being put on the stretch, the valve is opened, so that a certain quantity of water is allowed to escape, but the bladder is not completely emptied. A very small enlargement, however, of the middle lobe, projecting into the bladder, with the transverse membranous fold connecting it to the lateral lobes, is sufficient to produce a complete retention of urine.

It presents, says Rokitansky, the appearance of a rounded tumour, of the size of a bean or hazel nut, which projects into the neck of the bladder; it may increase to the size of a walnut, hen's or duck's egg, or more; and then protrude into the cavity of the bladder in the shape of a smooth or rough, nodulated, slightly lobular, rounded or cordiform, pyramidal, or cylindrical tumour.

This enlargement of the middle lobe may produce an apparent splitting of the urethra at the neck of the bladder; or the neck of the organ may be compressed and narrowed. The canal of the urethra where it passes through the enlarged prostate is generally flattened, and when the latter is divided transversely, the urethra appears like a slit, rather than like a cylindrical canal. As has been remarked, this canal is generally narrowed; but it has also been seen dilated into a "kind of sinus, where it lies in the centre of the prostate." The prostatic ducts may be enlarged so as to contain a considerable quantity of fluid, and to present upon post-mortem examination several fluctuating prominences. I remember to have seen, upon examining the bladder and its appendages of a man who died, at an advanced age, of retention of urine, an enlargement of both lateral lobes of the prostate, and several cysts formed of dilated ducts which projected from either side of the generally hardened mass on either side. There was no trace whatever of inflammatory disturbance ; the tissues surrounding these structures were perfectly healthy, and separated readily when dissected from the neighbouring parts to which they were connected by loose cellular tissue. One of the cysts contained as much as half an ounce of fluid.

As the gland increases in volume, the part juts out into the bladder, and some of the urine is kept back ; consequently the bladder is unable to expel the whole of its contents ; when the patient has voided all he has in his power to do, several ounces may still be left behind. The symptoms are then very distressing. The moment after urine has been passed the patient has an inclination to make more. He attempts to do so again, but only a little passes and no relief is obtained. In this manner he goes on all day, and at night he suffers still more. His sleep is broken, he is obliged to rise every quarter or half hour to relieve his bladder. He becomes at last haggard, thin, weak, and almost worn out from the irritation, pain, and watchfulness.

The symptoms which mark the commencement of this affection of the prostate become more severe if the disease be not arrested. The desire to micturate increases in frequency; the pain is more intense, and extends along the penis to the glans; the prostate is the seat of constant soreness, which may be throbbing or pulsative, hot to scalding, or even neuralgic in character. The urine becomes excessively fœtid and alkaline, and emits a strong ammoniacal odour; it is also occasionally mixed with blood. It is not difficult to recognise a patient suffering from hypertrophy of the prostate when striving to pass his water; he bends the body forwards; his legs are straddling or wide apart; he strains with all his might, and uses every muscle to overcome the resistance to the flow of urine. During these efforts the fæces sometimes escape involuntarily, and prolapsus of the rectum may occur. The stream of urine is small; a quantity escapes after the patient supposes that the bladder is emptied, and the clothes become soaked, wet, and offensive. The general health soon begins to fail; the tongue is loaded, there is little appetite, the feet are cold, the skin dry, and the bowels irregular. Exposure to atmospheric influences aggravate all these symptoms, and the state of the patient soon becomes deplorable.

Hypertrophy of the prostate produces some symptoms which may by possibility be mistaken for those of stone in the bladder. In the latter affection, however, the flow of urine is suddenly stopped at any period by the calculus falling across the orifice of the urethra; while in the former, the stream of urine having once commenced to flow, continues until the evacuating effort ceases.

The fæces are often flattened when the prostate is sufficiently enlarged to press upon the rectum; the same, however, may be remarked when the canal of of the gut is from any cause contracted. Satisfactorily to determine this point the patient must be examined per anum. For this purpose he may be placed on his back with the thighs bent and widely separated; or he may support himself upon his knees and elbows. The bowel having previously been emptied by an enema, the surgeon then introduces the index finger, well oiled, and runs it upwards along the mesial line, and then directs it from side to side. A space measuring about three inches longitudinally may thus be accurately examined, and enlargement of the prostate always detected. It is also requisite to employ the catheter, that deviations in the course of the urethra or changes about the neck of the bladder may be detected.

The irritation reflected from the hypertrophied prostate is apt to produce vascular excitement in the vesiculæ seminales, the walls of which become thickened and blended with the surrounding parts.

The kidneys not unfrequently sympathise; the capsule becomes firmly connected with the cortical substance by chronic inflammation; the effusion of lymph blocks up and compresses the minute vessels in the secreting substance, and the whole organ eventually becomes smaller and firmer than natural. The flow of urine, which during the period of vascular excitement had been increased, is now much diminished, and albumen, blood discs, and other abnormal elements are found mixed with the proper renal secretion.

I have not observed that the testicles suffer in these affections, although upon several occasions I have noticed that hydrocele has existed in patients who have consulted me for prostatic diseases.

Sir Everard Home (*Diseases of the Prostate Gland,* vol. ii., p. 28) observes, that where the middle and left lobe both project considerably into the bladder, their surface is sometimes excoriated, and has the appearance of being ulcerated. When this happens, the pain that occurs after passing the last drop of urine is very severe, and is attended with spasmodic affection of the neck of the bladder of the most distressing kind.

The first effect produced upon the bladder is inflammation of that part of the internal membrane in immediate contact with the tumour, for the muscular coat interposed between them is so involved in the thickened parts as to become entirely lost. This inflammation afterwards generally extends over its whole surface. The inner membrane of the bladder becomes in consequence extremely irritable : and this is a principal cause of the great and frequent desire, and consequent straining to make water, when there is only a very small quantity in the bladder. The irritation extends itself to the muscular coat, so that the bladder does not contain more than half the usual quantity of urine, before the most violent efforts are brought on to empty it.

In cases of chronic enlargement of the prostate, I have often seen the longitudinal fibres of the bladder greatly hypertrophied, and of red colour, passing in bundles over the thickened inner muscular coat, but the cellular tissue connecting them has always in complicated cases been loose and free, which would not be the case in a part previously the seat of inflammation.

The symptoms, therefore, of incipient enlargement of the prostate are irritability of the bladder, combined with difficulty in expelling the urine, which flows in a slower stream than natural. But when the prostate is once considerably enlarged, the patient is always subject to sudden aggravation of his symptoms, amounting to complete retention upon exposure to cold or indulgence in any excess. When the enlargement is slight, he usually attributes his sensations to internal piles. When the enlargement is greater, he feels a sense of weight and bearing down, and the desire to evacuate the fæces, although the rectum is empty.

As the disease advances, the urine is voided so slowly, that it drops perpendicularly from the orifice of the urethra, or perhaps dribbles away involuntarily; a slight degree of pain is experienced in the course of the urethra, and in the glans.

These symptoms are all increased by much standing or walking; rheumatic pains are felt down the thigh and leg, and likewise in the loins; occasionally there is hæmorrhage from the penis; there is constipation, dyspepsia, headache, and frequently some scaly eruption on the skin.

Owing to the prostate being intimately connected with the neck of the bladder, every increase in the size of the former must affect the latter, causing some alteration in the exercise of its functions. The loss of power to empty the bladder is apparently the first effect thus produced, and its consequences are very serious. If, after the patient has exerted himself to empty the bladder, an ounce or two of urine are left in it, the desire to micturate scarcely ceases before it returns.

Sometimes these symptoms occur suddenly. The patient awakes with a strong desire to micturate; he finds that he can scarcely pass any water; and, on inquiry, it is found that exposure to cold or wet, or irregularity in diet or exercise, had previously occurred. The mucous follicles increase in size, and the surrounding cellular tissue becomes thickened, till, at last, the prostate becomes considerably enlarged, and the desire to pass water, as well as the difficulty in voiding it, increase proportionably to the size of the gland.

Tumefactions of the prostate, which are said to be brought on by strictures, disappear when these are cured; it is necessary, therefore, to distinguish them from more permanent changes of structure.

A variety of causes have been assigned for hypertrophy of the prostate,—excessive venery, strictures of the urethra, riding on horseback, gonorrhœa, etc. That enlargement of the gland may also occur in persons who have led perfectly chaste lives is unquestionable.

Gonorrhœa is a disease common among the young, but uncommon in those of advanced years, in whom enlargement of the prostate is chiefly met with. Strictures of the urethra are usually classed among the exciting causes of this affection. Sir Everard Home entertained the opinion, but in his account of the cases which came under his observation, he has not confirmed his statement. Civiale, on the other hand, declares that the prostate is usually healthy in persons affected with permanent stricture; and Mercier thinks that so far from being a cause of hypertrophy of the organ, stricture of the urethra is calculated to produce atrophy.

It is at all times a difficult task to attempt the removal of the changes which occur in advanced life; and it must be confessed that we possess no certain means of diminishing the size of an hypertrophied prostate. The morbid change, once established, goes on until it interferes, more or less, with the expulsion of the urine, when surgical interference becomes indispensably necessary. Still these ultimate stages of enlargement may be retarded, and urgent symptoms may be so far prevented, that the patient may pass the remainder of his days in comparative comfort, under suitable treatment. He can by degrees learn what habits to pursue; what diet to adopt; and may acquire practical experience in the selection of suitable medicines, to act upon the alimentary canal. He should repose as much as convenient in the horizontal posture; avoid taking exercise upon horseback; abroad he should prefer carriage conveyance; and his walks upon foot should not be of a length to excite fatigue.

Should he be plethoric and of full habit, blood may be taken by venesection. In general, however, the subjects of this affection are not suited either by years or constitutional powers to bear general depletion. The bowels should be relieved of all accumulation; not by drastic purgatives, such as aloes or colocynth, but by the confection of senna, castor oil, supertartrate of potash, or sulphur. An occasional dose of blue pill, or of calomel, may be administered with advantage. I am a great advocate for the use of enemata. There seems to me no good reason for disturbing the whole length of the alimentary canal by purgative medicines administered by the mouth, when the end to be desired can be obtained by injecting a pint of warm water, or thin gruel with salt, into the rectum by the anus.

The food should be simple, plain, and nutritious. Wine, brandy, and other stimulating drinks should be avoided. Iodine has been strongly recommended, either given internally, or applied in the form of ointment to the enlarged structure. It may be ordered in the form of iodide of potassium, three grains three times a day, in water, sarsaparilla, or some other vehicle. No speedy change can be expected: the medicine requiring a considerable time to effect any important diminution in the gland. Indeed a patient may consider himself fortunate if iodine possess the power of controlling further enlargement; he then, at least, knows the extent of his ailments.

I believe cicuta may prove beneficial in some cases. It has been tried to a considerable extent in this country, and with apparent advantage. I usually give it in the form of extract, and frequently combine it with iodide of potassium.

Mercury is not a remedy to be employed here. We might as well attempt the dispersion of an enlarged thyroid gland by salivation, as the diminution of an hypertrophied prostate. The state of tender gums, disturbed appetite, morbid secretions, and irritable bowels, inseparably connected with the effective administration of this powerful mineral, is not one of indifference to the patient. We render him very uncomfortable, and he is but ill disposed to submit to such a state, unless with the anticipation of some decided benefit. This we cannot ensure him.

Counter-irritation is sometimes advantageous ; I prefer issues and setons in the perineum, to blistering in the region of the pubes ; but this mode of treatment was more in vogue when hypertrophy of the prostate was considered to be an inflammatory affection.

Suppositories of opium or of hemlock, as recommended long ago by Sir Everard Home, relieve irritation; and may lessen congestion of the organ consequent upon it. The warm bath, or warm fomentation, are useful for the same purpose.

Great care should be taken that the bladder be emptied at stated intervals. About four times a day, when the weather is warm and the atmosphere clear, will suffice for the relief of the organ. If the bladder be constantly called upon to expel its contents it becomes morbidly irritable, and the muscular coat is unduly thickened. If the urine be allowed to accumulate, the bladder loses its expulsive power entirely. The catheter is then required, and the patient rarely can free himself entirely from its use.

Hæmorrhage from the prostate, whether arising from ulceration, from the accidental rupture of vessels, or from injury by the catheter, may be treated by opium and galls, or the subacetate of lead with opium, in doses of from one to two grains of the former to one of the latter, every six hours, or by the infusion of roses with sulphuric acid and sulphate of alumen. In plethoric patients, or those subject to active hæmorrhage, such remedies should be preceded by general and local bleeding, injections of cold or iced water, &c. The catheter should, if possible, be avoided during hæmorrhage; or, if irritation and useless efforts to void urine render it necessary, it should be allowed to remain, in order to keep the parts at rest. The bladder, if filled by coagula, should be washed out.

In advanced life, the slow return of the blood from the neck of the bladder, caused by its low and remote situation, as well as the complication of its veins, tends to dilate these, and to favour an accumulation of blood in them. This gives a tendency to the disease, which, in elderly persons, is increased by violent horse exercise, by the irritation of the urine when of an irritable quality, dependent on a disordered state of the stomach and bowels, and especially by gonorrhœa and great sexual excitements.

The great relief which we can afford our patient is by the judicious use of the catheter; which may be either elastic, or of metal, the curve in the latter, being sharper than in the ordinary instrument, that it may the more readily pass over the obstructions at the neck of the bladder. With such an instrument it is rare that a careful surgeon fails in overcoming the class of obstructions which I have now been attempting to describe.

A winding passage is, sometimes, formed through the prostate, by alterations in the shape of its cavity; the channel being thrown to one side, frequently to the right one—a circumstance to be recollected on passing the catheter, when obstruction is felt at the neck of the bladder. It obviously is one of the cases in which an elastic catheter will pass easily without a stilet, though with difficulty or not at all, with one.

The catheter should either be passed every six or eight hours as the irritation returns, or it should be left in the bladder. In the latter case, after the first two or three days, it is a general rule to withdraw it, and re-pass it occasionally. If, however, it cannot be easily introduced, it will be better to secure it in the bladder, allowing the water to flow through it at intervals.

Sir E. Home says, that "wherever any degree of difficulty has occurred in passing the instrument the first time, it is always prudent to retain it in the bladder; for unless it is introduced again in five or six hours, its having been introduced at all is of little use; for in that period the bladder is generally as full as it was when the water was drawn off. Whether this arises from the accumulated fluid in the kidneys passing into the bladder, or from the pressure taken off from the mamillary eminences, making them secrete more freely, is immaterial; but the fact is of importance, since it makes it necessary again to empty the bladder, and the disturbance the parts received in the first operation, cannot so soon have gone off, and, therefore, must increase the difficulty in the second attempt."

The usual mode of securing the catheter, is to apply a common T bandage, of which the longitudinal band is divided, up the middle, into two portions, one of which lies in each angle between the scrotum and thigh, and to which the catheter may be secured by ligatures.

The following method has been found successful in difficult cases: namely, to pass a gum catheter as far as possible without a stilet, and this will probably be to the enlargement of the prostate; then to introduce a stilet into the catheter, without withdrawing the latter from the urethra; and, finally, to employ the stilet to direct the point over the tumour of the prostate.

Mr. Hey pointed out another method of using the catheter, which has now and then succeeded. The catheter is to be passed with the stilet to the enlarged prostate—then the stilet is to be partially withdrawn, a manœuvre which tilts up the end of the catheter, and may enable it to ride over the protuberant gland.

When the parts are irritable, Dr. Gideon Mantell, suggests that the catheter should be smeared with an ointment composed of five grains of acetate of morphium, and an ounce of spermaceti ointment; and relates an extremely interesting case of a large and inflamed prostate, in which this unctuous application was of great service.

When the entrance of the catheter into the bladder is prevented by the existence of a bar or valve, the point of a metallic instrument may be forced through it. This measure, requiring some amount of judgment and skill, is preferable to the more serious operation.

Hitherto we have been going on the supposition that, though there be an obstruction to the evacuation of the urine, it is to be surmounted by appropriate remedies and the employment of the catheter. But it happens at times, not merely in this disease, but in other affections both of the bladder and urethra, that all our endeavours to relieve the distended bladder fail; and in order to save the patient's life, our sole remaining resource is that of puncturing this viscus, and thus drawing off the urine. The spots usually selected for this operation, are either above the pubes or through the rectum.

The puncture above the pubes can be effected by a previous simple division of the skin, and separation of the recti and pyramidales muscles. A straight, long trocar is then to be used for the purpose of perforating the bladder ; care being taken to retain the canula, and, by the position of the patient, to guard against infiltration. This is the mode of puncturing the bladder usually preferred in cases of enlargement of the prostate.

The puncture from the rectum can be performed without injuring any important parts. A curved trocar in a canula is to be passed along the finger of the left hand to the triangular space, bounded by the vesiculæ seminales and peritoneum ; it is then pushed forwards into the posterior fundus of the organ. The instrument is then withdrawn, and the canula retained for a certain time, until the cause for the proceeding is got rid of. I have performed this operation several times, without the least difficulty, and it is the one which I prefer.

Mr. S. Cooper (*Surgical Dictionary*, p. 110) never saw a case in which retention of urine from chronic enlargement of the prostate gland terminated in extravasation of urine from rupture of the bladder. Sir Astley Cooper never met with but one instance of it ; and the reason of its rarity is given by Desault, who remarked long ago, that in every case of retention, where the urethra is free from obstruction, the urine, after distending the bladder to a certain point, generally dribbles away through that canal, and the patient may live a good while in this condition. But when the retention depends upon any stoppage in the urethra, the urine then does not partially escape ; the distension increases, and if relief be not speedily afforded, the urethra gives way behind the stricture or obstruction.

CHAPTER XXI.

CANCER AND TUBERCULAR AFFECTIONS OF THE PROSTATE GLAND.

We have the authority of Desault, Hunter, and Dr. Baillie, for saying that the prostate is the occasional seat of scrofula. Dr. Baillie, (*Morbid Anatomy,*) after stating that he has seen a common abscess situated within it, adds, that it is also subject to scrofulous disease, as, on cutting into it, he has met with the same white curdy matter which is formed in a scrofulous gland: he has likewise forced out of its ducts scrofulous pus.

"The prostate gland," says Mr. Wilson, (*On the Urinary Organs*, p. 330,) "is sometimes affected by scrofula. I have seen it enlarged and changed into a white curdy matter precisely the same in quality as that formed in a scrofulous absorbent gland. This swelling is slow in its progress; it is not attended with much pain; it may be felt by a finger introduced into the anus, and its effects on the stream of urine will depend upon the size it enlarges to and the form it assumes. In treating such enlargement, recourse must be had to sarsaparilla, cicuta, opium, liquor potassæ, sea-bathing, and electricity. Swellings of this nature are usually found in persons not advanced beyond the middle period of life."

Tubercle of the prostate, the only form of disease to which scrofulous can be correctly applied, is generally associated with the presence of tubercle elsewhere, particularly in the testes and vesiculæ seminales.

This morbid deposit of yellow colour, deeper than that seen in the lungs, is infiltrated through the substance of the gland, in larger or smaller masses, which soon become confluent and softened. Ulceration then ensues, and the whole interior becomes excavated into an irregular cavity, bounded by the prostatic capsule, and containing a mixture of tubercle and pus. Unless the contents be speedily evacuated by puncture from the perineum, there is great danger of the abscess bursting into the urethra or rectum ; and even under favourable circumstances it not uncommonly happens that this communication takes place from the encroachment and subsequent softening of the tuberculous masses upon the parts bounding the purulent collection. Under such circumstances the verumontanum and seminal ducts are destroyed.

It rarely happens, however, that tubercle is deposited in the prostate without being co-existent in the lungs, and patients so affected generally die of phthisis.

In the vesiculæ seminales, the tuberculous matter is deposited in a continuous layer, which produces ulceration of the mucous membrane. Shreds of ulcerated tissue, infiltrated by tubercle and floating in pus, are seen free within the cavity of this convoluted tube. The disorganisation may extend through its coats, and cause perforation of the bladder, when the contents of this latter organ will escape into the cavity of the abdomen, and cause death by peritonitis.

I have remarked that tuberculous deposit in the kidneys is in these cases frequently present. Small masses in the cortical substance, gradually increasing in size, become confluent and softened, as in the prostate, and an irregular cavity is formed containing a mixture of pus and tubercle. If the patient live long enough this abscess may burst internally; but it is generally combined with extensive disorganisation of other important organs.

In my own practice I have never met with a case of scirrhus of the prostate. We know how hard an organ may become when there is a small addition to its size by the deposit of even a soft material sufficient to distend, but not to weaken the fibrous capsule around it. I have frequently examined a testicle of stony hardness, which might have been pronounced a well-marked instance of scirrhus. Upon dividing the gland, after it was removed, I have found within the tunica albuginea a quantity of soft, perhaps semi-fluid, medullary cancer. Until, therefore, we can verify our conclusions by dissection, some doubt must remain as to the exact nature of these indurations of the prostate. "The so-called scirrhus of the prostate," says Civiale, "of which so much is spoken by Baillie, Desault, Chopart, and others, is nothing more than considerable induration of the gland, the tissue of which sometimes acquires sufficient consistence *pour crier sous le scalpel.*" As to cancer, properly so called, it is so rare that Cruveilhier affirms that he has never met with one. There are, however, instances on record.

Cancer in any shape, observes Rokitansky, rarely occurs in the prostate, which is curious as contrasted with the frequency of its occurrence in the uterus. Medullary carcinoma is occasionally found to attack the prostate, and to give rise to considerable enlargement of the gland ; it may sometimes perforate the fundus vesicæ and sprout into its cavity, causing a cancerous ulcer, with raised edges and varying size. My own experience agrees with these opinions. I have met with cases of medullary cancer, but not of true scirrhus.

Ulcerations of the prostate are generally associated with tuberculosis or with cancerous disease, occasionally with the presence of a calculus.

Mr. Stafford has related a case of malignant disease of the prostate in a child only five years of age. (*Med. Chir. Trans.*, vol. xvii., p. 220.) The gland was equal in size to the largest walnut, its form was somewhat globular, as is often the case with the enlarged prostate in advanced life. There arose from the prostate into the bladder, immediately behind the orifice of the urethra, a rounded nipple-like projection, nearly equal in size to a small hazel nut, and exactly resembling, both in its appearance and situation, the projection of the gland usually ascribed to an enlargement of its third lobe. On making an incision through one lateral lobe of the prostate, the cut surface exhibited none of the natural texture of the gland ; it was decidedly encephaloid in colour, consistence, and texture, and one part of the cut surface exhibited so dark a colour as to present the idea of there being melanotic mixed with the encephaloid matter.

It may be necessary to observe that the prostate gland in a child of five years of age, is about the size of a small hazel-nut; consequently its increase of volume, in this case, was immense, and even its third lobe alone was as large as the normal size of the whole gland itself at that period of life.

The bladder was contracted to about the size of a turkey's egg, and found to contain about an ounce of urine mingled with purulent matter. The mucous membrane of the bladder was somewhat thickened; in other respects this organ was sound.

Mr. Solly relates a case in the last number of the "Pathological Society's Transactions," of a child three years old, in whom the prostate was the size of a hen's egg. The tumour presented a cream colour on section, and a lobulated condition, with a fibrous tissue surrounding the lobules, giving it a gristly feel.

CHAPTER XXII.

PROSTATIC CONCRETIONS.

The calculi so often found in the prostate gland, although not properly ranked with the urinary calculi, must not be passed without notice. These calculi are composed of phosphate, with a little carbonate of lime and animal matter. They are found in the cells of the prostate gland, are usually small, and often rounded and numerous, but become irregular as they increase in size. Larger calculi, sometimes of considerable bulk, are occasionally found in abscesses and cysts in the prostate, these are smooth and sometimes highly polished, resembling porcelain in appearance. They are sometimes laminated with radiating striæ, at others compact. Occasionally they consist of the neutral phosphate, but far more frequently of the bone-phosphate. These calculi may be analysed by dissolving them in hydrochloric acid, and adding liquid ammonia, until all the phosphate of lime is precipitated, filtering and precipitating the remainder of the lime which existed as carbonate, by oxalate of ammonia.

The distinct calculi of the prostate gland are to be distinguished from the minute concretions which form in its follicles. The first have been long known, and have been described by many pathologists. The latter have been only of late brought under the notice of pathologists, and their microscopic appearances have been in particular described by Dr. C. H. Jones and Mr. Quekett. These concretions occur in minute follicles of the gland, and the average diameter of these follicles does not, as it appears, exceed the hundredth part of an inch. The colour of these minute bodies is deep yellow or red; sometimes, however, they are pale and colourless. Being so very minute, they are hardly distinguishable from the texture in which they are deposited. Dr. C. H. Jones thus describes their mode of formation: "They arise in a large oval vesicle of a single wall of homogeneous membrane. This is occupied by a colourless finely mottled substance, in the centre of which a nuclear corpuscle sometimes occurs. Their mean diameter is about $\frac{1}{1000}$th of an inch. In those of larger size the envelope is still seen, but the contained amorphous matter is beginning to be arranged in layers concentric to the envelope. In the further stage the vesicle measures $\frac{1}{200}$th of an inch or more, showing concentric layers which are more developed on one side than on another, like so many repetitions of the original envelope, the intervals between the layers being occupied by a finely mottled deep yellow or red substance. There is a central cavity corresponding with the external contour in its form, which is triangular, with rounded angles or quadrilateral. From this normal appearance these bodies present numerous variations in form and internal arrangement, and appear to occupy an intermediate position between organic growths and inorganic concretions: to the former by their vesicular origin and by their growth, which chiefly appears to take place by the dilatation of the vesicle and successive deposits in its interior; to the latter by their shape, their tendency to become infiltrated with earthy matter, and to pass into the condition of a dead amorphous mass of a deep yellow, red, even almost black. The chemical composition varies probably with their different stages of development, at first consisting of little else but animal matter, then acquiring, especially when in a state of degeneration, calcareous salts, stated by Dr. Prout to be phosphate with a little carbonate of lime. The colouring matter is unaffected by ether, liquor potassæ, and muriatic acid." (*Medical Gazette*, August 20th, 1847.)

According to Mr. Quekett, these concretions, are met with so frequently that they might seem to be a part of the constituents of the gland or its secretion. From his account it appears that the concretions commence by a deposit of earthy matter in the secreting cells of the gland; that they increase in size either by aggregation or by deposition in the form of concentric layers, and thus in the former case that they take the mould of the follicles, and in the latter that they exhibit on section the usual appearance of an uric acid calculus. He further says that the parietes of the adjacent cells in which a deposition has taken place are in contact and may be destroyed, so that on the addition of dilute muriatic acid by which the earthy matter is dissolved a many-celled cavity is left. Owing to the peculiar mode in which they mould themselves to the follicles, they not unfrequently present on the external surface an appearance resembling that of mulberry calculus.

Mr. John Adams, in a very able work on the "Prostate Gland" remarks, that the opinion of Prout as to the deposition of earthy salts being the result of a deranged action in a mucous membrane is fully borne out. "In a case," he says, "which I recently examined with Mr. Quekett, the concretions were exceedingly numerous, and this was especially remarkable in the middle lobe of the prostate. The second had been removed from a young man who had died of phthisis, and was of the natural size. The middle lobe was much firmer than either lateral lobe. These are soluble in acetic acid by the aid of heat."

Prostatic calculi appear to be connected in their origin with these minute concretions. For if these concretions do not undergo solution, and become removed they can hardly fail to become the nuclei of distinct calculi. And if this view be adopted, a complete explanation is supplied of the immense number of calculi met with together in the prostate gland. The calculi of the prostate are usually round and firm, somewhat transparent, having a pearly aspect so as in some measure to resemble grains of pearl barley. They are coated with brown, and this they seem to derive from the secretion of the gland. They gradually increase in size, and coming into contact with each other in the adjacent follicles, undergo a kind of articulation; their smoothness is so great that they put on the appearance of porcelain. In the progress of their development they cause absorption of the gland, so that it, or a par-of it, is at such times reduced to a sac, often composed of many cells, containing 50 or 60 calculi. When the prostate gland has passed into this state, it is felt through the rectum as if it were a bag full of marbles. At other times, a single cavity is found in one lobe, containing one large calculus. The smaller stones often escape through dilated ducts into the urethra, and may be extracted by the urethral forceps. The section of these calculi shows a radiated or laminated structure; in other cases the structure is compact.

The analysis of these concretions shows the presence of phosphoric acid and lime. Mr. Adams, in the work just quoted, regards the combination of these two substances in such calculi as reducible to two salts, namely, the neutral phosphate and the basic phosphate of lime. Those composed of the neutral phosphate are somewhat fusible before the blowpipe, and generally exhibit a crystalline structure; on the contrary, those composed of the basic phosphate are altogether infusible before the blowpipe. It should be remembered, however, that if the calculus under examination has passed into the bladder or urinary passages, it may have acquired a new coating on its surface. And thus when calculi formed in the prostate have passed into the bladder, that which was composed of basic phosphate of lime, and therefore wholly infusible, may have become fusible by a coating of triple phosphate. It appears also that when exposed in the prostatic portion of the urethra, such calculi become coated with uric acid. Mr. Adams says, "A single calculus sometimes projects from the prostate into the membranous portion of the urethra, which becomes much dilated. In this case, the calculus is usually of an elongated, somewhat conical figure, and consists of two or three separate portions, which are closely adapted to each other, and have polished articulating surfaces at the point of contact. The rounded extremity of one calculus is often received into a corresponding concavity of another. These calculi almost always contain a larger portion of phosphate and carbonate of lime than those found in any other situation. When the prostate is completely disorganised and converted into a mere cyst, the calculi found in its cavity are of the fusible character, or contain more or less of the triple phosphate."

It is sometimes observed that the urine becomes milky from the great abundance of phosphates secreted in the prostate gland, and finally mingled with the urine. This milkiness is to be distinguished from that which might arise from a deposition of phosphates from the urine, and the diagnosis will chiefly consist in the symptoms of irritation of the prostate gland and neck of the bladder, which cannot but accompany such a state of the prostatic secretion.

The symptoms produced by calculi in the prostate gland, will depend on their size, number, and situation. When small and not projecting, they sometimes have produced so little uneasiness, as not to have been suspected during life ; they are, generally, however, attended with some difficulty in voiding the urine, and a sensation of uneasiness about the neck of the bladder. This uneasiness is occasionally increased by violent exercise, but so it would be did it proceed from stone in the bladder. When they project towards the urethra, and produce a difficulty of passing the water, and an instrument is introduced either to search the passages, or the bladder, they will, in some instances, be found to grate against it, the calculi giving it that peculiar feel to the surgeon which cannot be mistaken; but they may be pushed by the instrument into the cavity of the prostate, so as not to be discoverable in several subsequent examinations. They have sometimes accumulated in such numbers, as to have been felt in the cyst through the rectum, and they have even ulcerated their way through the perineum.

When prostatic calculi are known to exist and cause irritation, an attempt must be made to remove them by means of Weiss' forceps. In some cases this can be easily effected, and several calculi have been taken from the same individual by this instrument. When the calculi are so impacted as to elude the grasp of the forceps, and the symptoms caused by the calculi are so distressing as to demand surgical treatment, the patient must undergo an operation almost similar to that for stone.

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